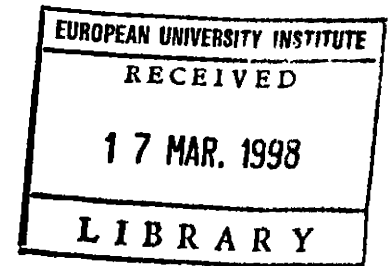




EUROPEAN UNIVERSITY INSTITUTE
Department of Economics



An Analysis of the Labour Supply Reactions of British Women to their Husbands' Unemployment

Aedin Doris

*Thesis submitted for assessment with a view to obtaining
the Degree of Doctor of the European University Institute*

Florence, January 1998

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An Analysis of the Labour Supply Reactions of British Women to their Husbands' Unemployment

Aedin Doris

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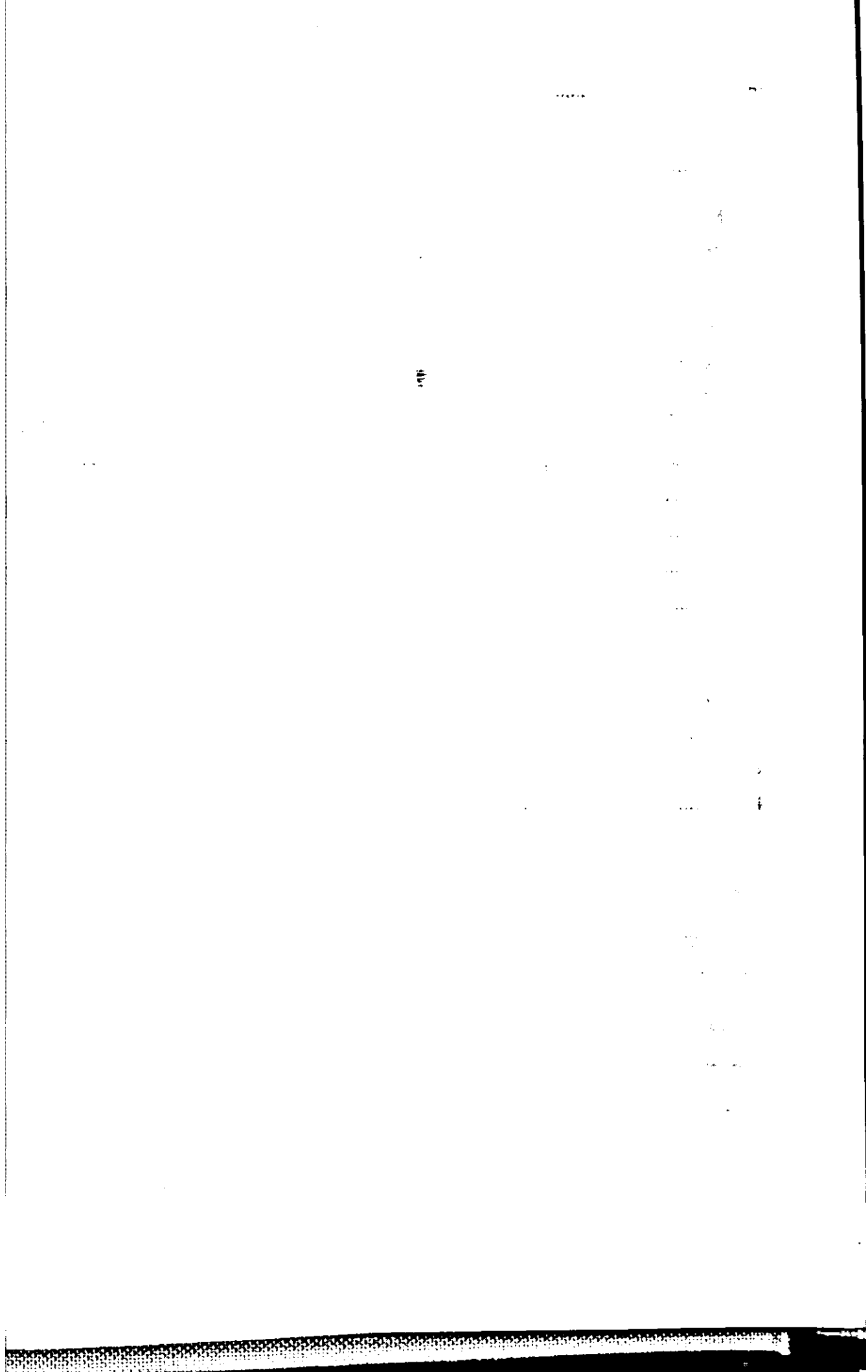
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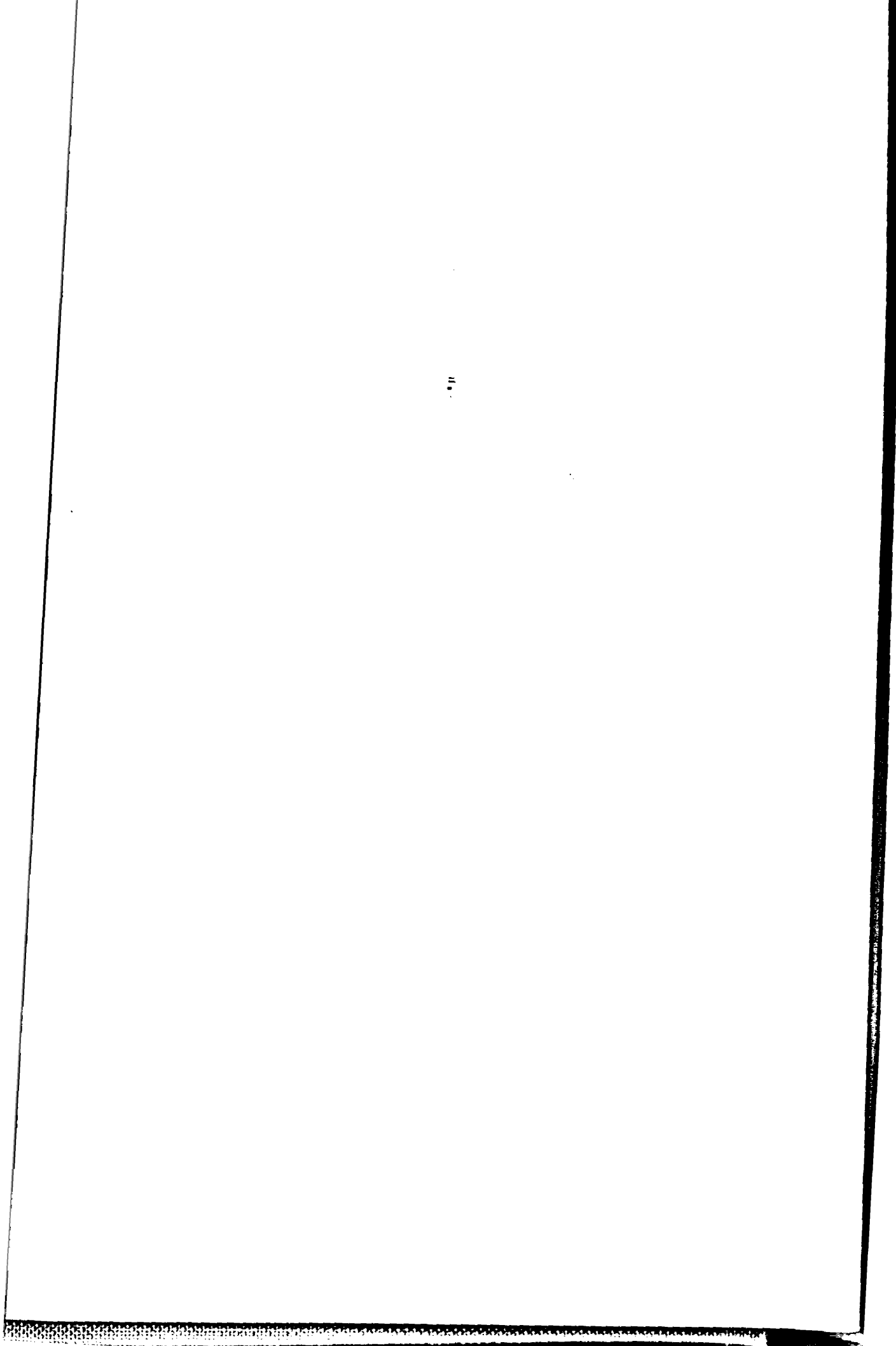
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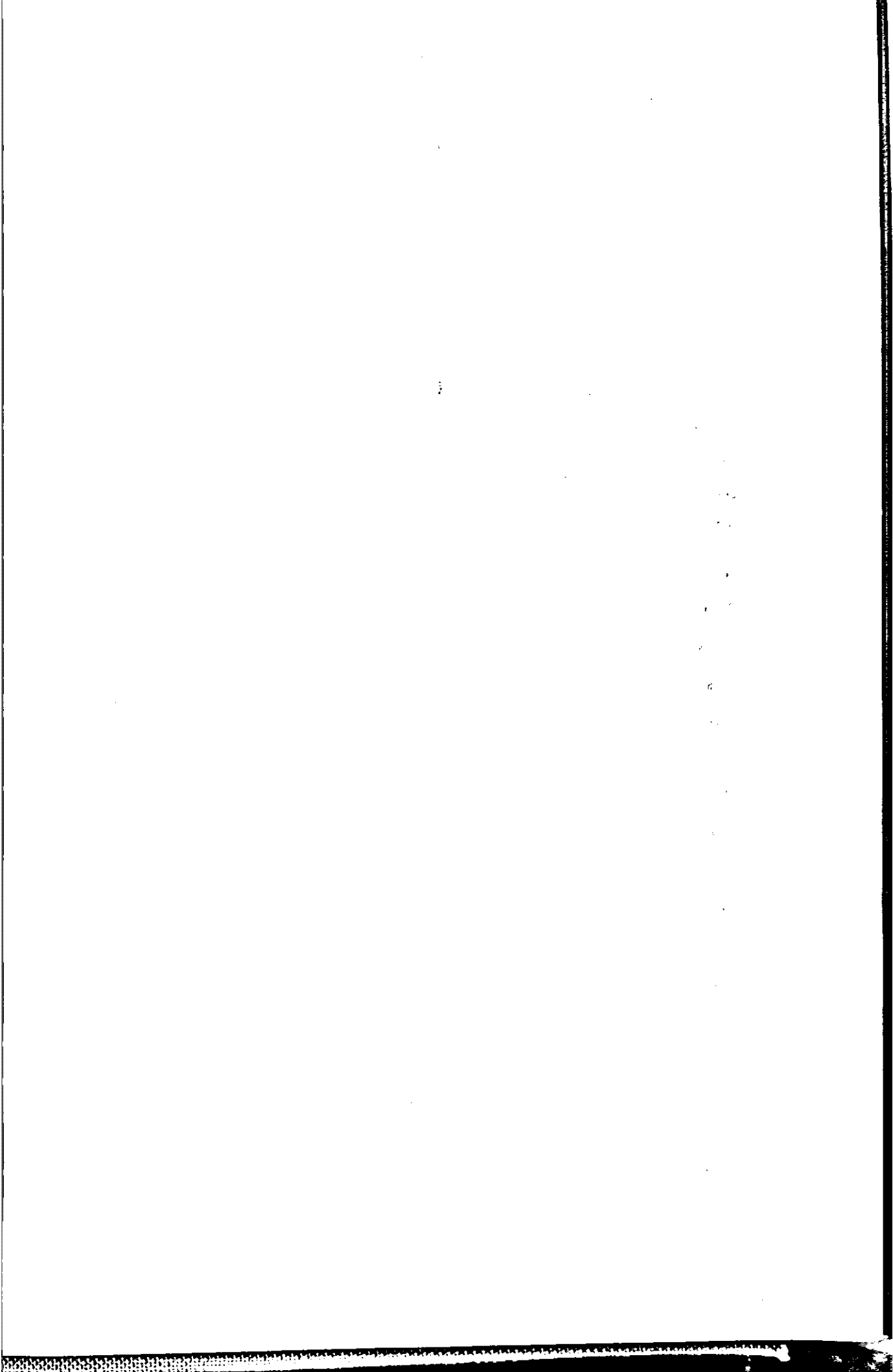
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1. Introduction

1.1 The Motivation for Studying the Wives of Unemployed Men

It is difficult to think of a more convincing justification for an investigation of the labour supply of the wives of the unemployed than that suggested by Table 1.1.

Table 1.1. The employment rates of married women in various countries, percentages.

Country	Year	LIS Data		Eurostat, PSID, HUS, DLDB		
		Husband Employed	Husband Unemployed	Husband Employed	Husband Unemployed < 1 Year	Husband Unemployed > 1 Year
France	1981	54.5	43.8	59.0	44.8	40.3
Netherlands	1983	31.0	26.9	36.6	26.7	14.4
Germany	1983	53.1	51.8	48.0	38.8	29.0
Italy	1986	37.3	41.2	37.2	9.8	14.0
UK	1979	61.5	47.3	60.9	33.6	18.4
US	1986	67.0	59.3	64.5	57.4	N/A
Australia	1985	61.8	22.7	-	-	-
Belgium	-	-	-	46.3	33.3	19.9
Canada	1987	65.8	45.7	-	-	-
Denmark	-	-	-	75.6	71.2	68.2
Greece	-	-	-	42.4	23.5	31.1
Ireland	-	-	-	24.6	19.7	13.4
Israel	1979	49.3	30.3	-	-	-
Norway	1979	68.0	42.6	-	-	-
Sweden	-	-	-	80.1	94.4	N/A
Switzerland	1982	43.9	26.4	-	-	-

Notes: 1. Figures in the 'LIS' columns are from the Luxembourg Income Study data. Differences in employment rates for Australia, Canada, France, Israel, Norway, Switzerland and the UK are all significant at a confidence level of 99%, and that for the US is significant at the 95% level. Source: Giannelli and Micklewright (1995). 2. Figures in the other columns are from the 1985 Eurostat Labour Force Surveys, except for the US (1986 PSID), Sweden (1984, HUS Panel Survey), Denmark (1985, Danish Longitudinal Data Base). Source: Dex *et al.* (1995).

This table shows that, with the exception of Sweden, and Italy¹ in the LIS data, the wives of unemployed men work less than the wives of employed men. Given that this table represents the situation in sixteen countries, the consistency with which this result is obtained is remarkable. Interestingly, the table also shows that in most of the countries for which such data are available, the longer a husband's spell of unemployment, the greater the difference in wives' participation rates in comparison with those of the wives of unemployed men.

This is not, however, the pattern that a text-book account of labour supply would predict. A woman's husband becoming unemployed is expected to have an 'added-worker effect' (AWE) on her labour supply, and indeed on the labour supply of other household members. The AWE is expected to arise because unearned income for family member j falls when member i loses a job,² thus reducing j 's reservation wage and making it more likely that she will enter the labour force, the pure income effect on j 's labour supply reducing the amount of leisure she can afford.

There are several explanations as to why the AWE might be absent, outweighed, or fail to translate into an increase in employment among the wives of unemployed men. Most fundamentally, it may be that casting the labour supply of women in terms of the household is simply inappropriate, and that women do not take their husbands' incomes into consideration when deciding whether to work or not. Such a conclusion would upset one of the tenets of the theory of labour supply, to the extent that it implies that membership of a household is irrelevant in making labour supply decisions. There are, however, other reasons that would explain the absence of an AWE within the context of a household model of labour supply, which should be investigated before drawing such a strong conclusion. These are enumerated here.

- Spouses live in the same place, so the shock to the local labour market that caused the husband's unemployment may also make it less likely that his wife is in work.

¹ Note that according to the Labour Force Survey data, the wives of the unemployed in Italy work much less than the wives of the employed, suggesting a difference in definition between the two surveys.

² In many models of household labour supply, the income of other household members is assumed to be treated in the same way as unearned or property income by an individual when making her labour supply decision.

This 'local labour market conditions' explanation suggests that the unemployment of a husband has an AWE on his wife's desired labour supply, but that she cannot increase her labour supply because of a lack of opportunities in the local labour market.

- Poor local labour market conditions may further act to suppress any AWE if they also make it more likely that the wife is a discouraged worker. A rise in the level of local unemployment may make unemployed workers in that area so discouraged about the possibility of finding a job, or, more formally, cause them to increase their expectation of the search costs of finding a job to the extent that they stop seeking work, thus becoming non-participants.
- There may be 'assortative mating',³ whereby marriage sorts individuals according to characteristics that are relevant to their labour supply, such as the level of education and taste for labour market work. In support of the hypothesis of assortative mating, Maloney (1991) reports that the correlation in cognitive ability between spouses is 0.9, which is higher than the correlation between siblings, or between parents and children. If this theory of the importance of 'similar characteristics' is correct, then the type of man who is more likely to be unemployed is also likely to be married to the type of woman who is unlikely to be employed.
- Leisure times of husband and wife may be complements rather than substitutes, again because of their liking each other, so that the AWE may be outweighed. This may be particularly relevant for older couples, if they regard a husband's unemployment as early retirement, albeit unplanned.
- Women may be very reluctant to take over the role of the 'breadwinner' in the household. McKee and Bell (1985) report that, in their interviews with couples in which the husband was unemployed, both husbands and wives mentioned, and indeed became emotional at the prospect of wives becoming the chief breadwinner, with stereotypes of the 'kept man' often mentioned.

³ Assortative mating is a cumbersome term that means that people who like each other tend to be alike.

- Women may take their decisions according to dynamic rather than just static considerations. In this case, it may be reasonable for a woman to continue not to participate in the labour market if she believes that her husband's unemployment will not last long enough to justify the transactions costs associated with finding a job, only to give it up again when he has returned to work, and the household situation returned to 'normal'. The mechanism for the suppression of the AWE in this case can be thought of as a kind of 'rational inertia'.
- Equally, in a dynamic context, there may be delays in putting into effect changes in desired labour supply, since it usually takes time to find a job, particularly if it is also necessary to make alternative child-care arrangements.
- The provision of Unemployment Insurance (UI), which insures individuals against the loss of income in the case of their becoming unemployed, replaces income, thus reducing the AWE.
- Social security systems that provide benefits in the case of unemployment which are means tested⁴ against family income may generate disincentives to work for a spouse that are unrelated to the benefit's function of replacing lost income.

It is this last explanation of the absence of an AWE which has been the focus of the attention of much of the literature that exists to date on the labour supply of the wives of unemployed men. This is understandable, as only this explanation of the absence of an AWE is directly affected by government policy. Few commentators suggest that there should be no public provision of an alternative source of income to ensure a minimum level of welfare in the case of genuine unemployment. But the possibility that the administrative rules governing the entitlement to such income may discourage women from entering the labour market in order to offset the loss of household income, or, worse, encourage working women to leave the labour market, is an unhappy one, suggesting that these rules may increase the likelihood that a spell of unemployment entails long-term poverty.

⁴ 'Means testing' means that the individual's entitlement to a benefit is judged on the basis of whether his other resources, or means, are low enough to justify its receipt.

In the light of the possibility that it is the means testing of benefits that generates the unexpected result that the wives of the unemployed are less likely to be employed, it is interesting to see whether there is a pattern of correlation between the rate of employment of women married to unemployed men in the countries included in Table 1.1 and the type of benefit system that operates in those countries. The details of the benefit systems in these countries are given in OECD (1988).

In fact, it is difficult to see a pattern of this type. For example, the largest difference in employment rates is that for Australia, where the wives of the unemployed are less likely to be employed than the wives of the employed by 39 points, and in Australia, all unemployment payments are means-tested, there being no UI scheme in operation. This supports the hypothesis that the means testing of benefits is crucial in explaining differences in employment rates. On the other hand, in Canada, where there is a difference in employment of 20 percentage points, only non-means-tested UI is available, up to 60% of gross wages being paid for up to 12 months, depending on the employment record of the claimant and the regional rate of unemployment.

In Sweden, where the wives of the unemployed work more than the wives of the employed, unlike in other countries, there is no means testing of benefits, and benefits are available indefinitely, lending support to the means testing explanation of the differences between countries in the table. And in the Netherlands, where the difference in employment is at the lower end of the scale, the Unemployment Assistance (UA) benefit is means-tested, but since Unemployment Insurance (UI) is paid, at 70% of the previous gross salary, for up to 36 months, many unemployed households are never subject to a means test to qualify for benefits.

But on the other hand, in Belgium, where there is a difference of 13 points in employment rates, the benefit system is based only on UI, so that no benefits are means-tested. Similarly, in Norway, where the wives of unemployed men work much less than the wives of employed men, by 25 points, the system provides only non-means-tested UI, with 62% of the gross wage paid for 19 months.

It seems that, although the means testing of benefits may have a role to play in the explanation of the lower rates of employment of the wives of unemployed men than

of the wives of employed men, the other possible reasons for the absence of the AWE given above must also be factors, to varying extents. This thesis attempts to establish the relative importance of the various reasons, in one country, the UK.

The remainder of the chapter is as follows. Section 1.2 explains why the British case is particularly interesting to study. Section 1.3 describes the British benefit system, including the reforms which have been implemented recently. Section 1.4 gives an overview of the existing literature on the subject of the labour supply of the wives of unemployed men, both British and otherwise. Finally, in Section 1.5, the approach taken in the remainder of the thesis to examining the labour supply of the wives of the unemployed in Britain is outlined, and the structure of the thesis explained.

1.2 The Motivation for Studying the British Case

There are two primary reasons why the labour supply of the wives of unemployed men is a topic that is particularly interesting in Britain.

First, the difference in the labour supply of wives according to the labour supply status of their husbands is particularly high in Britain. Table 1.1 showed that according to 1979 LIS data, the difference is 14 points, a difference that is significant at the 99% confidence level, whilst the Labour Force Survey data from 1985 indicates a difference of 27 points in the employment rate. Even more strikingly, Pudney and Thomas (1992, 1993) mention that, according to the 1989 General Household Survey, 71% of women married to employed men were in work, whilst just 28% of those married to unemployed men were. This indicates a difference in employment between the two groups of 43 points, a remarkable statistic.

Thus, the wives of the unemployed in Britain are interesting because they work significantly less than the wives of the employed. It also seems possible from these figures that the gap in employment rates is growing over time, although the differences in the figures given above may be due to changes in definitions between surveys and over time. However, Kell and Wright (1988) show that information from one survey, the General Household Survey, indicates that between 1973 and 1984, the participation rate of the wives of unemployed men decreased, whilst that of the wives

of employed men increased, leading to a increasing gap in participation rates between the two groups.

The second major reason why Britain is interesting is because of its benefit system. In Section 1.3.1, this system is described in general terms, so here it is necessary to say only that the degree of means testing that has applied in Britain has been high. Moreover, the system has recently been changed, according to proposals which came into force in late 1996, in a way that extends the means testing of benefits further. Therefore, if it is the case that means testing has been an important disincentive to work for the wives of the unemployed in the past, then these changes to the system, detailed in Section 1.3.3, can be expected to widen the gap in employment between these two groups of women even further. The implications of the further concentration of unemployment and non-participation in the labour force into particular households, in a country where income inequality has been increasing since the 1980's, are clear.⁵

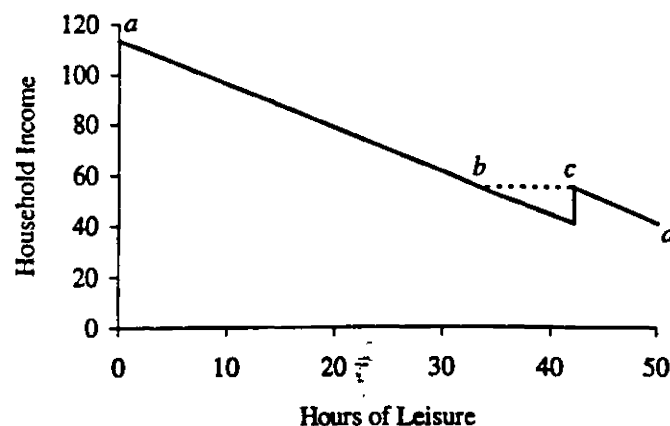
1.3 The British Benefit System

1.3.1 The Benefit System in the UK, 1983-1984

In the UK, the social security system has two tiers. Unemployment Benefit (UB) is received by those who have built up an entitlement to it by making insurance contributions during previous periods of working; it is, therefore an insurance-based benefit. UB is paid only for a year, after which time the unemployed person drops to the second tier of the system. This second tier is Supplementary Benefit (subsequently Income Support), which does not depend on insurance contributions, and is therefore classified as an Unemployment Assistance (UA) benefit.

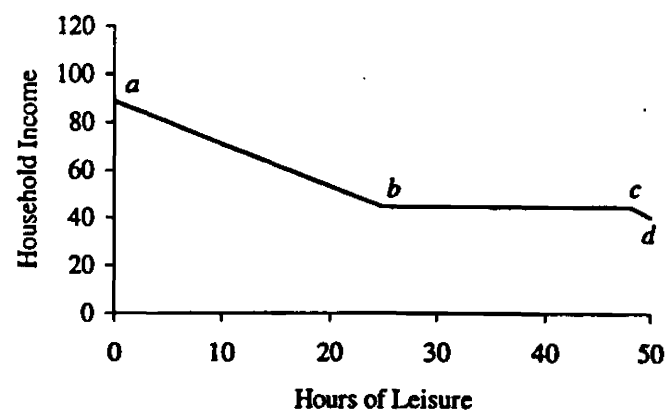
⁵ Gregg and Wadsworth (1996) document the increasing polarization between workless households and other households in OECD countries and conclude that, for the UK, most of this polarization can be attributed to the increasing numbers of household types with an incidence of worklessness that is typically high, such as single parent families. Nonetheless, a higher than average proportion of increased polarization was found to be due to increases *within* household types in the UK.

Figure 1.1. The budget constraint faced by the wife of an unemployed man who receives UB.



Note: The budget constraint is calculated for an hourly wage rate of £1.77, the average net wage in the LSUS data used later in the thesis, and for a UB entitlement of the husband of £25, plus £15.45 dependant's allowance. These were the prevailing rates in 1983-84. The tax system is ignored.

Figure 1.2. The budget constraint faced by the wife of an unemployed man who receives SB.



Note: The amount of SB entitlement illustrated is the same as for Figure 1.1 when the wife works zero hours, so that the differences between Figure 1.1 and Figure 1.2 reflect only the difference in treatment of the wife's income between UB and SB.

The budget constraint associated with UB is shown in Figure 1.1. UB is not means-tested except that an addition for a dependant spouse is paid only if she is earning less than the amount of the addition. This means that there is a region on the

household budget constraint where family income is lower if the wife works than if she does not, between b and c in Figure 1.1. In effect, this rule introduces an element of means testing into the British UI scheme, which is unusual, resulting in the normal distinction between UI and UA being blurred to some extent.

SB is means-tested, so that earnings of other family members cause a reduction in benefits paid⁶ one-for-one with those earnings, beyond a £4 disregard. This means that the benefit to a wife's working is just £4 unless she is earning more than the family's SB entitlement; the marginal tax rate on her earnings is effectively 100% between the level of the earnings disregard and the amount of benefit entitlement, between b and c in Figure 1.2. The disregard operates over the short range of hours between points c and d .

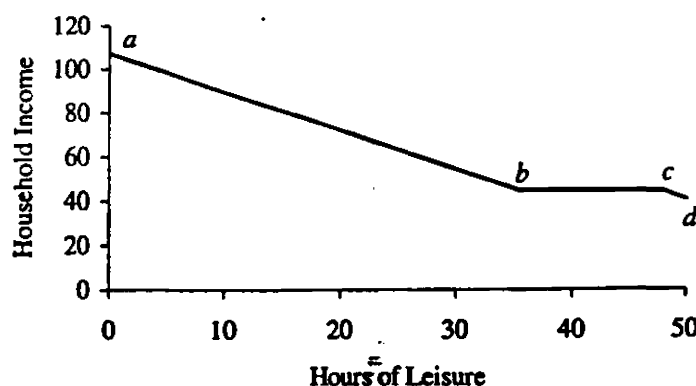
It can be seen by comparing Figures 1.1 and 1.2 that the range of hours over which there is no gain from working an extra hour is greater for the wife of an SB recipient than for the wife of a UB recipient. It is also clear that the effective *average* tax rate is generally higher for a woman whose husband is on SB.

If the needs of a household receiving UB are judged to be above its resources, including UB, then SB may be received in conjunction with UB. Unlike the situation in many other countries, the level of UB, which is usually classified as a UI-type benefit, is flat rate, so that it is unrelated to the level of previous earnings. Moreover, the rate of payment is low. Thus, just 29% of unemployed claimants were receiving UB in November 1983, for example (Department of Social Security, 1989). The budget constraint that is relevant to many households whose head qualifies for UB when unemployed is, therefore, that illustrated in Figure 1.3. Although this budget constraint resembles that depicted in Figure 1.2, it is notable that the flat region of the budget constraint, from b to c , extends over a smaller range of hours than in the case of a woman whose husband is entitled only to SB.⁷ Moreover, the absolute level of household income is higher at all hours of work of the wife beyond b .

⁶ Ownership of more than £2,000 of financial assets also reduces entitlement to benefits.

⁷ 12 hours compared to 23 hours in the examples shown in Figures 1.2 and 1.3.

Figure 1.3. The budget constraint faced by the wife of an unemployed man who receives both UB and SB.



Note: The amount of UB entitlement illustrated is the three-quarter rate of £18.75 plus £11.59 dependant's allowance, with household income topped up to £40.45 by SB. Thus, the total benefit entitlement at zero hours of work of the wife is the same as for Figures 1.1 and 1.2.

A third benefit that is means-tested is housing benefit (HB). If the household qualifies for SB, then rent and rates are automatically paid by HB, but if the household does not qualify for SB, then a comparison of needs and resources is made that typically results in a payment that is less than the amount of the rent, so that ineligibility for SB affects household income also through its effect on the basis on which HB is calculated.

It is clear from the above description of the benefit system that much of the income that is made available by the State in the case of unemployment is means-tested, even when a claimant is eligible for coverage under the UB scheme. It should also be noted that the extent of means testing increased when the earnings-related supplement formerly included in UB was ended in 1982, since it increased the number for whom it was necessary to top up UB income with SB, thus increasing the range of income of the wife over which there was no benefit to working.

1.3.2 Indifference Curve Analysis

This section provides some comparative static analysis of the effects of several possible reforms on the effect of the means testing of benefits. Figure 1.4 shows the effect of increasing the level of SB payments on the labour supply decision of a woman not

working initially. The diagram shows that non-participation will remain her optimal choice, although the extra income to the household will raise her utility, as indicated by the shift from indifference curve A to B.

Figure 1.4. The effect of increasing the level of her husband's SB payment from £40.45 to £60 per week for a woman not working under the present system.

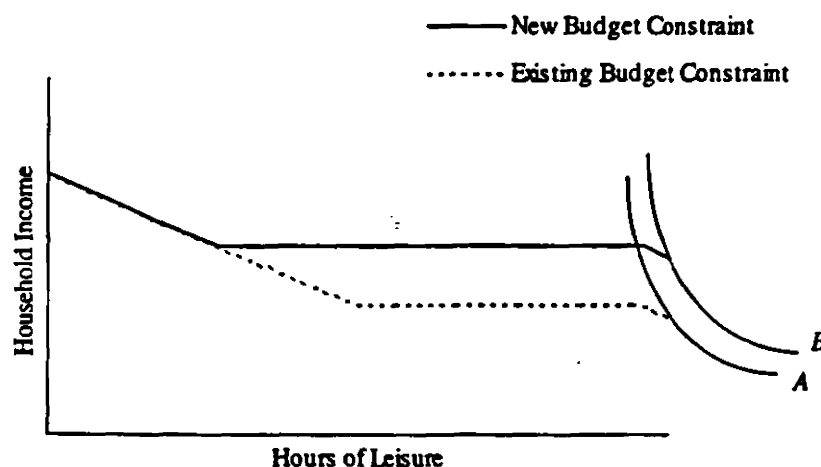
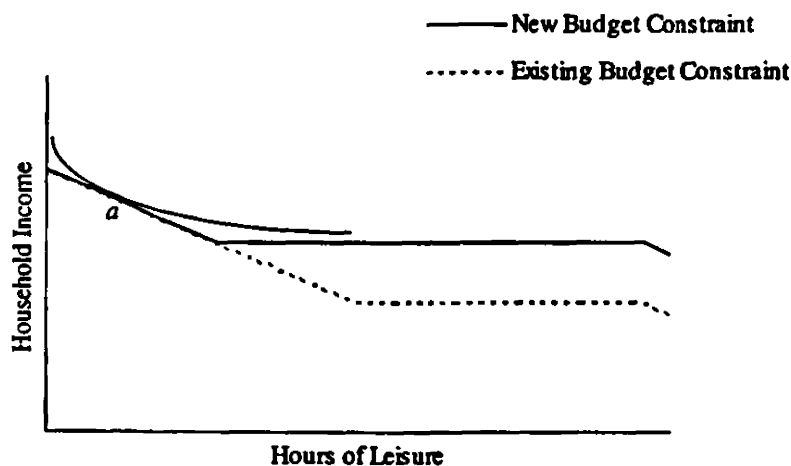


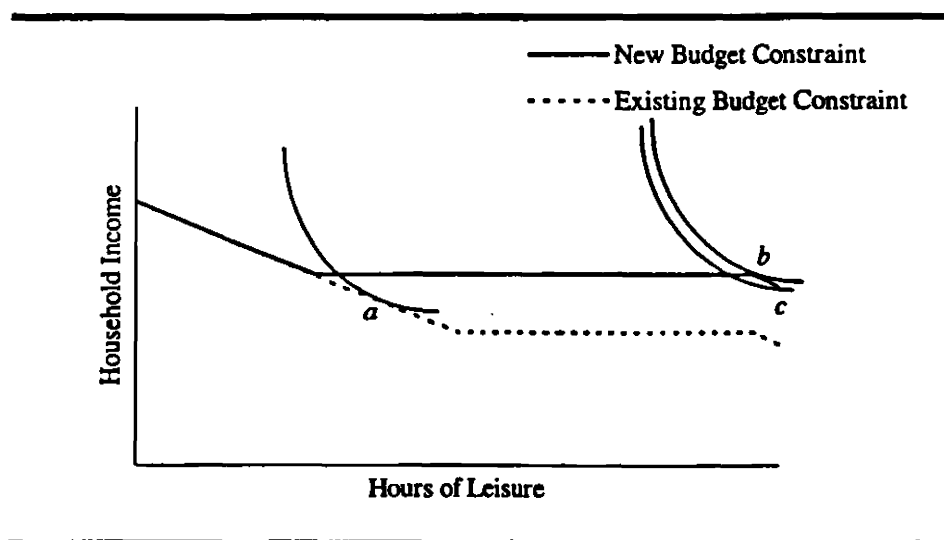
Figure 1.5. The effect of increasing the level of her husband's SB payment from £40.45 to £60 per week for a woman working full-time under the present system.



In Figure 1.5, it can be seen that for a woman initially working the hours indicated by the tangency shown at *a*, corresponding to full-time work, the increase in the SB entitlement makes no difference to her optimal hours decision. However, if her initial point of maximization is at a lower level of hours of work, working part-time,

then the increase in SB will cause her to reduce her hours of work. This is shown in Figure 1.6. Here, the woman reduces her hours to those represented at the kink point, *b*. Note that if fixed costs of working are important, or if there are demand-side factors which make offering such a low level of hours expensive for employers, then this low level of hours of work may not be feasible, in which case, the best available alternative may be non-participation, at point *c*. Note also that a woman with a different indifference map could optimally choose to cease working after such an increase. This is an interesting result; an increase in the SB entitlement of a household may make a woman who is working initially less likely to participate, or may cause her to reduce her hours of work to those represented at the kink point where the earnings disregard is exhausted, if this is feasible.

Figure 1.6. The effect of increasing the level of her husband's SB payment from £40.45 to £60 per week for a woman working part-time under the present system.



A reform which could be introduced in order to reduce the disincentive to participate in the labour market caused by means testing is illustrated in Figure 1.7. Here, the earnings disregard for the wife is increased from £4 per week to £15 per week. Again, for a non-worker, this reform has no effect on the probability of participation. But note that if the woman's optimal choice prior to the increase in the disregard is, in fact, the kink point on the existing budget constraint at *b*, with non-participation observed because it is the second best choice given the non-availability of jobs with such low weekly hours of work, then the second best option may, after the

reform, be on the region between b and c , which is more likely to be offered by employers.

Figure 1.7. The effect of increasing the earnings disregard for SB entitlements of her husband from £4 to £15 per week for a woman not working under the present system.

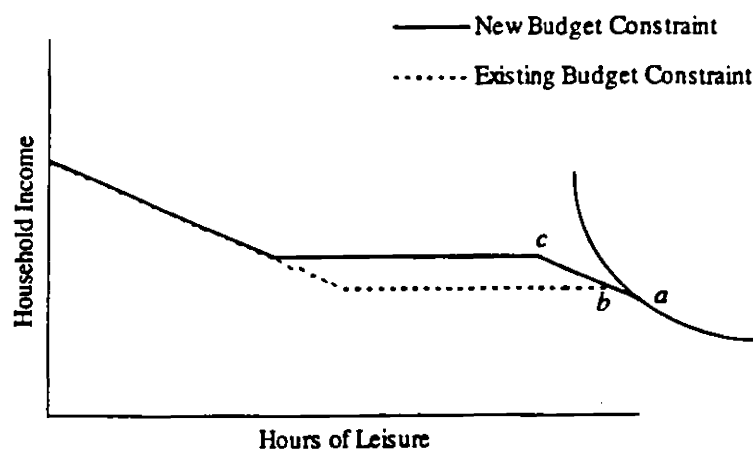
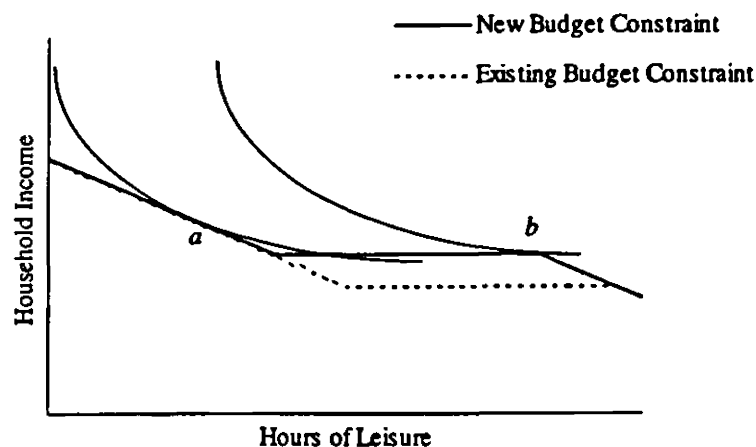


Figure 1.8. The effect of increasing the earnings disregard for SB entitlements of her husband from £4 to £15 per week for women working full-time under the present system.

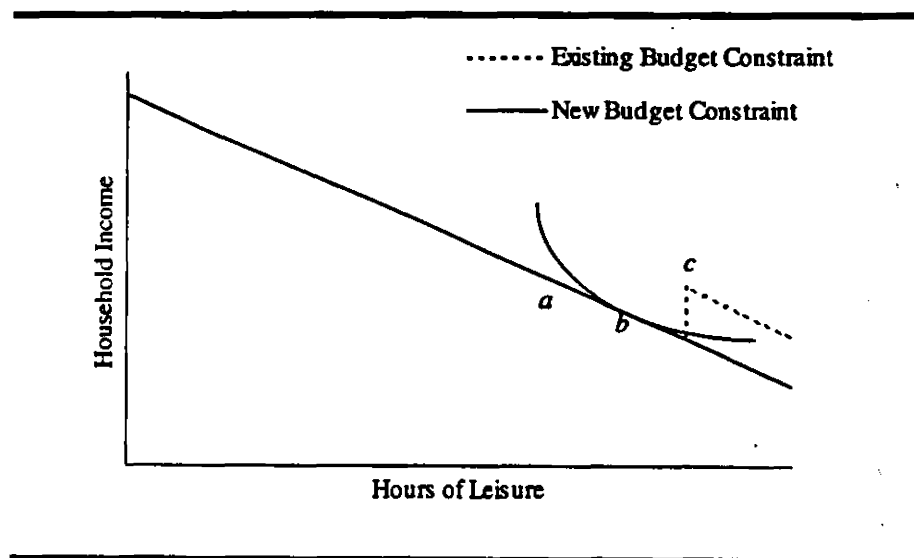


Note, however, that such a change in the means testing structure of the system may make a difference to the optimum number of hours of work. Figure 1.8 illustrates the case of a woman working initially, at point a , who is better off if she works the low number of hours indicated by b after the increase in the disregard. Thus, this reform

may entail changes in the optimal number of hours of work, and not just the participation decision.

Finally, Figure 1.9 illustrates the effect of abolishing the dependant's allowance of UB. This would eliminate the kink in the UB budget constraint, so that a tangency at point *b* would be possible, whereas under the present system, no woman will work between *a* and *c*.⁸ Thus, the disincentive to work caused by the element of means testing in UB would be eliminated. However, the consequence of the household being more likely to need SB to bring income up to that identified as the minimum necessary under SB entitlement rules would tend to increase the range of hours over which a spouse was not prepared to work.

Figure 1.9. The effect of discarding the dependant's allowance of UB.



From the above analysis, it is clear that the interaction of UB and SB entitlement complicates the revision of the optimal hours of work decision in the light of reforms of the Social Welfare system considerably. In the next section, the reforms that have been put into effect very recently are discussed.

⁸ Note that locating at the kink point *c* may be optimal for some at present.

1.3.3 Recent Changes to the UK Benefit System

The interest in the possibility that the means testing of benefits generates a disincentive effect is heightened by the fact that the British government has abolished UB and SB and replaced them with contributory Job Seekers Allowance (JSA) and means-tested JSA respectively. These benefits are the same as the benefits they replace, except in the following important details:

- The duration for which UB is payable has been reduced from a year to six months. Then, the higher degree of means testing associated with SB applies to the income of many more unemployed people. Since two thirds of the inflow into unemployment find work within six months (Employment Gazette, 1994) and about one third of unemployed people qualify for UB, approximately 10% of the inflow into unemployment are likely to be affected by this change in regulation. Of course, a higher proportion of the stock of the unemployed will be affected.
- The dependant's allowance paid with UB has been abolished. This means that the amount of UB payable has fallen; thus, a higher proportion of households will qualify for top-up SB as well as UB, so that more wives face the budget constraint shown in Figure 1.3, rather than that shown in Figure 1.1.
- A 'Back to Work' bonus has been introduced, specifically with the aim of reducing the disincentive to re-enter the labour market of both claimants and their spouses. The previous situation was that for every £1 earned beyond a £5 disregard, SB was reduced by £1. Under the new scheme, a credit of 50p is built up for every £1 earned by either a claimant or his spouse in part-time work, defined as less than 16 hours per week for a claimant and less than 24 hours per week for his spouse, and, on finding a full-time job, also defined as working over 24 hours per week, the amount of credit built up is re-paid in a lump sum.

This aspect of the recent reforms is particularly complex, because it increases the importance of dynamic considerations in the decision-making process. For example, a woman has to weigh up the probability of her husband finding a job in the future, and if that is unlikely, whether she will wish to work full-time in the future. It also makes part-time employment a much more attractive option than

full-time work in the short-term, since if a woman begins to work full-time, 'Back to Work' credits are not built up.

A less important point included in the reforms is that the higher earnings disregard for long-term unemployed has been abolished, so that their wives, if not participating, are less likely to begin to participate, as illustrated in Figure 1.9 above.

1.4 A Survey of the Existing Literature on the Labour Supply of the Wives of Unemployed Men

The literature that exists on the subject of the labour supply of the wives of unemployed men is small, and diverse both in methodological terms and in the results obtained. The work that has been carried out is introduced in this section and the support that has been found for each of the explanations of the labour supply of the wives of unemployed men offered in Section 1.1 is then discussed in turn. Finally, the conclusions that can be drawn from the review of the literature are outlined.

Three papers have been published which examine the added worker effect (AWE) without reference to the role of unemployment payments in determining labour supply; they all refer to the US, where unemployment payments are not means-tested, which may explain the absence of a focus on benefits. These papers are by Lundberg (1985) and Maloney (1991 and 1987).

In Lundberg (1985), the question of whether there is an AWE of a husband's unemployment is cast in terms of changes in the probabilities of transitions between labour force states when one family member becomes unemployed, where the labour force status of the wife, given her labour supply in the previous month, is modelled separately for each possible labour market status of the husband; for both husband and wife, the labour force status may be either employment, unemployment or non-participation. If there is an AWE, employed wives are less likely to leave employment when their husbands are unemployed, non-participating wives are more likely to enter the labour force and unemployed wives find more jobs acceptable, because of the lowering of their reservation wages caused by the reduction in household income, and thus become employed more quickly. The data used are from the Seattle and Denver Income Maintenance Experiments panel, collected between 1969 and 1973.

A second paper that focuses on the AWE emphasizes the importance of unobserved characteristics in determining labour supply, an issue that is not specifically addressed by Lundberg. Maloney (1991) attempts to distinguish between three explanations for the absence of an AWE in aggregate data - local labour market conditions, similar characteristics in husbands and wives and complementarity of leisure times of the spouses; the 1982 wave of the Panel Study of Income Dynamics (PSID) is used.

As in Lundberg's paper, the emphasis is on participation rather than hours worked. Here, however, the model used is a static one. The core of the approach used is the decomposition of the probability of unemployment of the husband into an ageing component, a permanent component that summarizes the effect of all personal characteristics other than age on the probability of unemployment, and a transitory component. If the AWE outweighs any complementarity of leisure times of the spouses, then the transitory component of the husband's unemployment probability should lower the wife's reservation wage, and if complementarity dominates, the opposite is true. If transitory factors causing both to be unemployed, such as local labour market conditions, are the source of the outweighing of the AWE, then the transitory component of the husband's unemployment should reduce both the wife's participation probability and her market wage. Finally, if characteristics common to both husband and wife are obscuring the AWE, then the permanent component of the husband's unemployment probability should reduce the wife's market wage.

In a further paper, Maloney (1987) uses the 1976 wave of the PSID, and a model accounting for constraints on the labour supply of both the husband and wife, in terms of upper limits on hours worked as well as in terms of unemployment *per se*.

Gruber and Cullen (1996) focus on the effect of Unemployment Insurance on the labour supply of spouses in the US. To test for the effect of UI, predicted UI payments are included in a model in which the unit of observation is the husband's spell, so that the dependent variable is the average labour supply of the wife during a spell, and there may be more than one spell per person. The data used are the 1984-88 and 1990-92 panels of the Survey of Income and Program Participation. Here, labour supply is measured both in terms of hours of work and participation. Tobit and Heckman selectivity bias-corrected models of hours worked are estimated, as well as a

participation model; both hours and participation models are also estimated with couple-specific fixed effects,⁹ to account for heterogeneity.

European work on this subject tends to focus to a greater extent on the possibility that it is the disincentive effect of means testing that obscures the AWE, even in the absence of data on benefit entitlement. An example of such a study is provided by Davies *et al.* (1992). Here, a fixed effects model of the monthly labour supply of the wife is used on data from the Social Change and Economic Life Initiative Survey, which contains life history data¹⁰ on married couples in six British localities, and was collected in 1987. In order to capture the effect of means testing, the duration of a husband's unemployment is used. Since UB is payable for a maximum of 12 months, after which point SB, which is much more heavily means-tested, is payable, a difference in the behaviour of wives according to the length to date of their husband's unemployment spell is expected. The problem with using this as a way of capturing the effect of means testing is that it takes no account of the fact that many men do not qualify for UB at the start of their spell of unemployment, nor that many households qualify for both SB and UB at the same time in the first twelve months of unemployment. Both of these matters will tend to blur the 'twelve month effect' sought.

Giannelli and Micklewright (1995) also use the twelve month effect as one way of assessing the disincentive, if any, of means testing for the wives of the unemployed. In this case, the country studied is Germany, using five years of monthly data from the German Socio-Economic Panel, beginning in 1984. The receipt of Unemployment Assistance (UA) is first used as an indicator of the means-test disincentive. This is also a problematic variable for capturing any disincentive effect, but this time because of its endogeneity. Since the wife's income, and hence labour supply, is used to determine the entitlement, if any, to UA, the receipt of UA is endogenous to the wife's labour supply, so that the causality of the relationship being investigated is reversed, a problem that is recognized by the authors. Two models are used: one is a model that

⁹ How these fixed effects models are estimated is not clarified. If, as seems possible, the estimates are from an unconditional fixed effects model, then the results of the participation model are inconsistent. I return to this point in Section 4.2.1.

¹⁰ This term refers to data recording relevant events throughout life, collected retrospectively.

accounts for heterogeneity by incorporating individual effects that are fixed over time, whilst the other is a model of transitions between employment and non-employment.

Another paper in the literature that uses a dummy for the receipt of means-tested benefits to indicate the disincentive effect is Dex *et al.* (1995). This paper is unusual in that it is a cross-country study; the countries included are Britain (1980), Ireland (1986), the US (1986-87), Sweden (1984) and Denmark (1980). Cross-section models of participation are estimated separately for each country.

Again for Britain, Kell and Wright (1990) use the 1983 Family Expenditure Survey (FES) to estimate the effect of means-testing of benefits on the labour supply of wives. Here, they account partially for the endogeneity of the receipt of benefits by including a dummy for the entitlement of the household to SB if the wife works zero hours. The receipt of UB is used as an indicator of a non-means-tested benefit, which is not problematic, given that receipt of this benefit does not depend on the wife's labour supply, although the amount received does. The model is also an improvement on others that have been estimated in that it allows for a distinction between participation on a part-time or a full-time basis, which is clearly important. However, the distinction between part-time and full-time work is not extended to the variable for the entitlement to SB, although the receipt of SB certainly depends on the hours worked by the wife. Labour supply is modelled as a double hurdle; the decision to participate is taken first, and, conditional on participation, the wife chooses between full-time and part-time work.

There are three studies, all for Britain, which explicitly model the budget constraint generated for the wives of unemployed men in order to assess the effects of the means testing of benefits. In this way, the problem of the endogeneity of the receipt of benefits is overcome. Garcia (1989, 1991) uses data that have the advantage that they come from a survey of the unemployed, the DHSS Cohort Study of the Unemployed, conducted in 1978. The data used here are from a cross section, and the model is therefore static. Three budget constraints are possible, for the case where the husband works full-time, where he is unemployed and entitled to UB, and where he is unemployed and entitled to SB. For all three situations, the budget constraints are convex at the point of participation, but for the third case, where there is an SB entitlement, this convexity arises only because of the £4 disregard of the wife's

earnings. In this situation, it is assumed that the £4 disregard does not exist, presumably because of the difficulty in reality of finding a job with very few hours per week, and so the fact that the resulting budget constraint is non-convex at the point of participation must be addressed. On the other hand, the discontinuity in the budget constraint for UB receivers' wives at the point of the withdrawal of the dependant's allowance is ignored.

In order to deal with the non-convexity on the SB budget constraint, a Constant Elasticity of Substitution (CES) utility function is specified, and a threshold condition for a wife's participation is derived from this utility function. For those whose husbands are entitled to SB, this is complicated, as it requires the calculation of the optimal hours of work on each segment of the budget constraint that lies beyond the flat segment that reflects the 100% marginal tax rate of the withdrawal of benefits, using the type of procedure proposed by Burtless and Hausman (1978); hence, the threshold condition that is relevant is specified.

The likelihood function is specified so that the contribution to the likelihood of an individual depends on whether the husband receives SB or not, and the sample likelihood is maximized with respect to the coefficients on the parameters of interest as well as the elasticity of substitution of the utility function and the standard error of the random variable that defines the participation threshold condition. The variable used to capture the means-testing disincentive is the level of entitlement to SB of the husband if the wife does not work.

Papers by Pudney and Thomas (1992, 1993) also model the budget constraint, albeit in a more reduced form context than Garcia's. Their model also allows both for a distinction between part-time and full-time work and for some dynamic aspects of the decision making process. This is possible because they exploit the panel structure of the data they use, the Survey of Incomes In and Out of Work, collected in Britain in 1987. They estimate a model which jointly estimates the desired states at the beginning and end of the nine month sample period together with the time taken to make any transition; for women who make no transition and for women who make a transition into unemployment, allowance is made for the possibility that the destination state may be as observed because of a delay in the implementation of a decision to change to a new optimal state. The modelling of the observed states entails a conditional logit

model with three possible desired states, whilst the time to transition is modelled as having a log-normal distribution.¹¹

Finally, a recent paper by Bingley and Walker (1996), also for the UK, uses a third approach to the estimation of the determinants of the labour supply of the wives of the unemployed which again entails the modelling of the budget constraint beyond the participation margin; like Pudney and Thomas, the authors choose to model the constraint as a series of three discrete points. The data used here are pooled from fifteen years of FES cross-sections, 1987-1992, giving a large sample size.

The approach used is the estimation of a discrete choice, multinomial probit model of a wife's labour supply jointly with models of the rationing of both the wife's and husband's labour supplies, using information on unemployment collected in the surveys. Unusually, rationing is also a multinomial variable, with distinctions drawn between short-, medium- and long-term unemployment, presumably to indicate the degree to which the individual is constrained. However, the concept of rationing used is not entirely clear, since, for example, the ages of children are significant determinants of being constrained for both husbands and wives.

Variation in tastes is allowed for by using a random coefficients, co-varying disturbances model of choice, as suggested by Hausman and Wise (1978), which means that the error term in the labour supply model is not problematic, since it no longer includes unobserved variation in tastes. The error terms of the husband's rationing equation and the wife's labour supply choice are allowed to be correlated, although the correlation between the wife's unemployment and labour supply equation errors is restricted to zero, as is the correlation between husbands' and wives' unemployment error terms; this latter restriction would appear to rule out the possibility of shocks to the labour market affecting both spouses.

The results obtained using these various approaches are discussed below.

¹¹ In Pudney and Thomas (1993), the time to transition is modelled using a truncated normal distribution.

1.4.1 Local Labour Market Conditions and the Discouraged Worker Effect

The importance of the local unemployment rate may be assessed in two ways. One way of addressing the issue is to focus on whether a husband's unemployment is positively correlated with a wife's unemployment. Finding such a positive correlation is inconclusive, however, as it may indicate that the wives of unemployed men have higher reservation wages, perhaps because of unobservables such as lower taste for labour market work. Moreover, examining the matter in this way requires data on participation in the labour market, both employment and unemployment, rather than just the former.

The alternative is to include the local rate of unemployment as a determinant of either participation - both employment and unemployment - or of employment. Where used as a determinant of participation, a negative effect indicates a discouraged worker effect, whilst as a determinant of employment, it also reflects true labour market constraints.

Maloney (1991) tests explicitly for the effect of local labour market conditions on the labour supply of women married to unemployed men. In a preliminary analysis, he finds that the county unemployment rate has a negative effect on the employment probability of married women that is significant at the 1% level. He then goes on to use a more elaborate model in order to distinguish between the effect of the local unemployment rate on the probabilities of both participation and employment conditional on participation and the effect of shocks to local labour markets. He finds that the local unemployment rate has a negative effect on labour force participation, but not on employment conditional on participation, suggesting that a high local unemployment rate discourages women from participating in the labour market. He also finds that the 'transitory' component of the husband's unemployment - the shock to the local labour market - has no effect on a wife's participation probability, but has a negative effect on her employment probability. Thus, the evidence suggests that both the increase in the discouraged worker effect and the reduction in job opportunities due to a high local unemployment rate are important factors in the effect of the latter on the employment probabilities of the wives of unemployed men.

Using a different approach to the subject, Maloney (1987) finds that accounting for the possibility of wives being unemployed or under-employed dramatically increases the estimates of the effects of a husband's unemployment or underemployment on his wife's labour supply, tripling her predicted annual hours. The main conclusion of this paper is that, although a wife's labour supply is found to be positively associated with her husband's unemployment, this response is often unobserved. This suggests that the discouraged worker effect of a high local unemployment rate is unimportant, a result that contrasts with Maloney (1991), but that its effect in reducing the probability of finding employment is crucial.

In Bingley and Walker (1996), the rate of regional unemployment is included as a regressor in rationing equations for both husbands and wives, where it reflects a true demand-side constraint, with a strong effect in the expected direction for both husbands and wives. Dummies for the husband's rationing are included in the wife's labour supply equation as well as the unemployment rate, and the rationing and labour supply equations are estimated simultaneously, so that the effect of the unemployment rate on labour supply reflects only a discouraged worker effect; the coefficient on the unemployment rate in the labour supply equation is significant and negative. Overall, the authors conclude that a 1 point increase in the unemployment rate reduces the wife's employment probability by 0.8 points, of which about three quarters is due to discouragement, with the remainder due to the increasing constraints.

Other studies are less conclusive in their findings about the importance of local labour market conditions. Thus, Gruber and Cullen (1996) find that the relevant female unemployment rate by state, level of education and year has an effect on the labour supply of married women that is only marginally significant for employment and insignificant for hours of work. Lundberg (1985) examines the transitions from non-participation to unemployment for wives of unemployed men compared with those for the wives of employed men to indicate the role of local labour market conditions in suppressing the AWE, since the data used contain information on unemployment. The results show that for white and Hispanic wives, the relevant transition rate is higher for the wives of unemployed men, about twice as high for white wives, but is almost exactly the same for black wives of employed men as for black wives of unemployed men. Overall, the evidence suggests that the wife of an unemployed man is more likely

to be unemployed if she decides to enter the labour market than the wife of an employed man, but as pointed out above, it is not certain that this result arises because of constraints in the local labour market, as it may be that the wives of unemployed men have higher reservation wages.

Several studies have found no effect of the local unemployment rate. Among these are Kell and Wright (1990) who find no effect of the regional rate of female unemployment on either participation or hours of work and Dex *et al.* (1995) who report that regional-level demand indicators are insignificant for the countries in their study. Similarly, Pudney and Thomas (1992, 1993) find no significant effect of the local unemployment rate and suggest that demand-side constraints operate on labour supply by depressing wages.

1.4.2 Similar Characteristics of Husbands and Wives

In accounting for the similar characteristics of husbands and wives in determining a woman's reaction to her husband's unemployment, both observables and unobservables are relevant. However, it is only in accounting for unobservables that difficulties arise. These unobservables may be specified as either individual-specific or couple-specific; but in neither case can the extent to which these unobservables are similar in both spouses be measured. Hence, the emphasis in the literature is on abstracting from unobservables, where data allow such effects to be tackled, with an assumption implicitly made that these unobservables are indeed correlated between spouses.

For the UK, Davies *et al.* (1992) account for unobserved heterogeneity both by including an individual-specific error term and by allowing for a 'stayer' component in the model, and find that both of these features significantly improve the explanatory power of their model, indicating the importance of this explanation. Education is observable for both husbands and wives in one of the six localities studied, but it is difficult to interpret the results obtained, as no data on wages or household income are available, so the extent to which educational qualifications proxy taste for labour market work is confused with the correlation between wages and education. However, when the 27 point shortfall in employment between the wives of employed and unemployed men is decomposed, they find that the account that is taken of

heterogeneity, both observed and unobserved, accounts for about 17 points of that shortfall.

Using German data, Giannelli and Micklewright (1995) also reach the conclusion that unobservables are important, by estimating both models that take account of unobserved heterogeneity and models that do not, and testing the former against the latter using a Hausman test of the hypothesis that unobservables are unimportant. This null hypothesis is firmly rejected.

On the other hand, Gruber and Cullen (1996) find for the US that accounting for couple-specific fixed effects has little effect on their estimates of labour supply. The details of the estimation method used are sparse, so this result may be aberrant for econometric reasons. Moreover, no formal test of the result is reported. Many of the relevant unobservables have been successfully proxied by variables such as the husband's work history and job type, and also by the husband's entitlement to UI, which is also correlated with labour market characteristics. Such variables do not have direct explanatory power in an analysis of a woman's labour supply, so their significance must arise because they are effective proxies of her husband's labour market characteristics, which she shares. Thus, these results are consistent with the importance of common characteristics.

The above-cited papers all use panel data to draw conclusions about the importance of common characteristics. In studies that use cross-section data, it is much more difficult to allow for this factor, a fact that is reflected in the neglect of the issue in many papers. In one paper based on cross-sectional data, Garcia (1991) allows for heteroskedasticity of the errors by specifying their distribution as a function of the educational qualifications of the wives, and finds that the results as to whether specifying heteroskedastic error terms is necessary to be inconclusive. This may be the result of having assumed a specific functional form for the errors, which, if incorrect, may not account for individual-specific effects adequately.

Bingley and Walker (1996) use a random coefficients, co-varying disturbances model, which entails the estimation of the effect of a deviation of the individual's tastes from the average, and in this way allows for individual-specific effects. These effects are significantly different from zero. Moreover, the duration of a husband's

unemployment, if any, is included in the wife's labour supply regression, with results showing insignificant effects of the husband's having a short unemployment spell, but large significant effects reducing the probability of the wife's working for longer unemployment spells. Given that the longer spells have larger effects, this result might also be interpreted as reflecting unobserved characteristics shared by husband and wife.

Maloney (1991) uses a third approach to cross-section data to isolate the effect of common characteristics on wives' labour supply. Here 'permanent' aspects of a husband's unemployment are separated from 'transitory' ones; the permanent component, which summarizes the impact of all personal characteristics apart from age on the probability of the husband being unemployed has a large significant negative effect on the probability of the wife being observed in employment, and this is found to be because, although it positively affects the labour force participation probability of the wife, it also negatively affects the market wage of the wife, and increases the wife's unemployment rate.

1.4.3 Complementarity of Leisure Times of Husbands and Wives

According to this explanation of the level of labour supply of the wives of unemployed men, women choose not to enter the labour market, or indeed drop out of the labour market when their husbands become unemployed because they enjoy spending time with their husbands.

It is important to note here that it is not possible to distinguish between this explanation and an alternative explanation given in Section 1.1 of the absence of an AWE at the aggregate level, that women are reluctant to become the household's breadwinner when the husband becomes unemployed. It seems likely that if this is the source of the complementarity of leisure times, rather than a more positive desire to spend time together, then the effect will be stronger for women who do not usually work than for those who usually do work, because in the latter case, continuing in a job already held would not have the same significance as for a woman who has never worked during her married life beginning to work, for example.

The complementarity of leisure times can be isolated only once the financial effects of unemployment and similarities in characteristics have been accounted for.

The conclusions of the existing literature as to the importance of the complementarity of leisure times between husbands and wives in determining the reactions of wives to their husbands' unemployment are mixed. Pudney and Thomas (1992, 1993) find that complementarity of leisure times is a significant determinant of the labour supply behaviour of the wives of unemployed men, the coefficients on dummies for the husband's unemployment being large, negative and significant in the model of the wife's choice of labour market state, even after the effects of changes in household income and adjustment delays have been accounted for. They conclude that in the absence of this complementarity, a slight AWE would emerge, and hence that complementarity is a dominant factor in the labour supply decision.

Bingley and Walker (1996) also include the husband's unemployment in the wife's labour supply equation, although in this case, they use three dummies for short-, medium- and long-term unemployment of the husbands. The effects are found to be significant for both medium and long spells of unemployment, in a direction consistent with complementarity of leisure times. However, the significant differences between the coefficients for long and medium spells raise questions about the interpretation of these coefficients as reflecting complementarity.¹² Whilst it might be argued that some increase in the effect of the husband's unemployment might be expected as the spell lengthens, because of delays in implementing decisions or because the longer the spell, the more worthwhile a transition becomes, it seems that some unobserved heterogeneity is being captured here also, so that the extent to which this result is due to complementarity of leisure times alone is difficult to determine.

Maloney (1991) finds inconclusive evidence of complementarity of leisure times being the reason for the absence of an AWE. He points out that the transitory component of a husband's unemployment should raise a woman's reservation wage if leisure times are complementary, but lower it if there is an AWE. He finds no effect of

¹² The interpretation of complementarity is not, incidentally, made by the authors, who see the role of these regressors as allowing for the endogeneity of the husband's labour force status to the wife's labour supply.

this transitory component on reservation wages, so that either it is the case that neither complementarity nor an AWE arise, or both do, and offset each other.¹³

In Davies *et al.* (1992), no distinction is made between any means-testing effect and complementarity of leisure times between husbands and wives; instead reference is made to a 'cross-couple state dependence'. It is true that there is evidence of a twelve month effect, with a husband who has a spell of a longer duration causing his wife's probability of employment to reduce. However, some of this effect may well be due to complementarity of leisure times between husbands and wives.

In their model, Gruber and Cullen (1996) find that having accounted for couple-specific fixed effects, a husband's unemployment still has a negative effect on his wife's probability of employment, which may indicate complementarity of leisure times.

Using German data, Giannelli and Micklewright (1995) find that, even after unobserved characteristics have been accounted for, a husband being unemployed or out of the labour force reduces the probability of a wife participating in the labour market, indicating complementarity of leisure times. Curiously, before unobservables have been factored out, the effect of a husband's unemployment is positive, suggesting that the unobservables work to increase her participation, which is difficult to rationalize.

In none of the models estimated by Kell and Wright (1991) are both the husband's unemployment and the effect of means testing included. Where the husband's unemployment is included, it has a large, negative, highly significant effect on the wife's participation, but it is difficult to be sure that this is capturing complementarity of leisure times, as neither unobserved characteristics nor the effect of means testing are controlled for here.

Garcia (1991) does not explicitly mention the possibility of the complementarity of leisure times in his analysis. He does include the unemployment of

¹³ Note that the author concludes that complementarity of leisure times cannot be the reason for the absence of an AWE, as the transitory component of the husband's unemployment also raises his wife's market wage; however this conclusion would appear to be rather strong given that the relevant coefficient is insignificantly different from zero.

the husband as an explanatory variable in the participation estimation, and indicates that he expects it to have a negative coefficient in line with complementarity; the coefficient is, however, reported to be positive, although insignificant.¹⁴

In the remaining studies, no mention is made of complementarity of leisure times, and no inference can be drawn on the topic from the results reported, as either benefit effects or unobserved heterogeneity, or both, have not been accounted for.

1.4.4 Inertia and Adjustment Delays

In Section 1.1, it was noted that the fact that women make their labour supply decisions in a dynamic rather than a static world may be very important in suppressing any AWE. First, if women expect their husbands to return to employment relatively quickly, then they may be reluctant either to give up a job if they are in employment, or to search for a job if they are not. Secondly, there are delays in implementing decisions taken to change employment status. Finding a job takes time, particularly if child-minding arrangements must also be put in place, while in order to give up a job, some notice must usually be given in advance of leaving.

Few studies to date have focused explicitly on adjustment delays as a reason for the absence of an AWE. An exception is Pudney and Thomas (1992, 1993), who find that such delays are central in explaining this fact. The authors account for adjustment delays by estimating the time taken to a transition jointly with the choice eventually made. Only dummies for the type of transition made are included in the specification of the adjustment delay, but only for transitions from full-time or part-time work to non-participation are the effects significant. This runs contrary to expectations, since the transition from non-participation to work might be expected to entail a longer delay than a transition from work to non-work. In particular, it is difficult to believe that the mean adjustment lags are as estimated - over two and a half years for exiting part-time work, and almost four years for exiting full-time work. These results surely indicate unobserved heterogeneity that is unaccounted for rather than adjustment delays in the sense of difficulties in putting into effect decisions that have already been taken. In

¹⁴ In the text, the author claims that the coefficient is significant and negative, which renders commenting on this result difficult.

particular, it seems likely that some individuals who are inherently stayers are driving these results.

None of the other existing studies claim to have captured the effect of inertia or adjustment delays in their analyses, preferring to view adjustment delays as deviations from the utility maximizing outcome, but those that are inherently dynamic can be assessed for evidence of such delays nonetheless. Thus, for example, in Davies *et al.*, the current state is allowed to depend on the state in the previous month, in a first-order Markov structure, which will account for any differences between the rates of transitions out of work and those from non-work into work. When this is introduced, much of the employment shortfall between the wives of employed and unemployed men previously ascribed to cross-state dependence is accounted for - about nine points of a ten point shortfall; this may be because of unobserved heterogeneity being successfully reflected in the initial state occupied, but may also be due to adjustment delays.

On the other hand, Lundberg (1985), finds that transitions into employment are more probable than transitions out of employment in the sample she uses, after demographic and income variables have been taken into account, a pattern that is not expected to arise if finding a job takes more time than quitting a job.

Finally, as noted in previous sections, Bingley and Walker (1996) find that the longer her husband's term of unemployment, the less likely a woman is to work, which may indicate that a woman waits to see if her husband's situation is likely to last before making the transition which is optimal.

Other papers on the subject of the labour supply of the wives of unemployed men are set in static frameworks, so that no evidence of the importance of adjustment delays and inertia can be inferred.

1.4.5 Unemployment Insurance and the Added Worker Effect

The AWE arises because a husband's unemployment entails a drop in income for the household, which is a drop in non-labour income for his wife, and which therefore reduces her reservation wage and makes it more likely that she will participate in the

labour market. Clearly, the extent of the AWE depends on the amount by which household income is reduced by a husband's becoming unemployed.

The benefit system replaces income lost due to unemployment. The income the system provides to an unemployed man may be means-tested, as described in Section 1.3.1, in which case the issues involved are not related to the presence of an AWE, since the means-tested income received is endogenous to rather than exogenous to his wife's labour supply. A negative effect on the labour supply of wives of exogenous income is a necessary condition for the emergence of an AWE. However, it is important to note that if low market wages or low tastes for labour market work are also present, or if there is a strong complementarity of spouses' leisure times, an AWE will not occur. Thus, testing for the importance of a reduction in a husband's income is not synonymous with testing for an AWE.

Gruber and Cullen (1996) find no evidence of an AWE in their data, and conclude that this is due to the payment of UI, as they find that non-participation would drop by 45 points in the absence of UI. Thus, their conclusion about the importance of replacement income when a husband is unemployed is a strong one.

Maloney (1991) does not include UI payments in his analysis, maintaining that they would have no effect on an AWE, although this is certainly not true; clearly any compensation for lost income will reduce the AWE. The husband's wage income has a negative effect on a woman's labour supply, suggesting that the amount of UI received would also affect labour supply. However, the author does test for an AWE by inspecting the effect of a husband's unemployment *per se* on a wife's reservation wages; finding no such effect, he concludes that no AWE occurs because of the extent to which common characteristics determine wives' labour supply.

Pudney and Thomas (1992) do not separate endogenous from exogenous income received by the husband, so that the results for the husband's income cannot be taken as an indication of an AWE. However, the authors do carry out simulations to isolate any AWE, and find that only in the absence of a very strong complementarity of leisure times does a small AWE emerge.

Simulations conducted by Bingley and Walker (1996) show that if a woman's husband finds a job, the effect of the change in household income alone, abstracting

from the fact of his being employed and any consequent complementarity effects, is to increase the probability of a woman's participation by over 6 percentage points, spread fairly evenly between part-time and full-time work. This indicates that there is an AWE of the change in the husband's income.

In some other studies, it is difficult to interpret the effects of UI on the recipients' wives' labour supply. For example, in Dex *et al.* (1995), a negative effect of the receipt of UB is reported for both Britain and Ireland, but it is difficult to interpret this result since the benefit receipt variables also reflect the fact of a husband's unemployment, and therefore any unobserved characteristics that this might represent, as well as any complementarity of leisure times between spouses. A similar problem arises in Kell and Wright (1990). Where the husband's unemployment is controlled for in this study, UB receipt has a significant positive effect on the wife's probability of participation, which is inconsistent with an AWE, and probably indicates the type of women whose husbands receive UB as opposed to SB.

1.4.6 The Means Testing of Unemployment Payments

The results of the studies published to date regarding this issue, which is the crucial one associated with the labour supply of the wives of unemployed men, are very mixed. Pudney and Thomas (1992, 1993) find that the income received by a woman's husband has no significant effect on her labour supply; this result emerges from a model that specifies the household budget constraint carefully, as well as taking into account the dynamics of the labour supply decision.

On the other hand, Bingley and Walker (1996) find clear evidence that means testing generates a disincentive to work for the wives of the unemployed. In simulations, they find that a shift from UB entitlement to SB entitlement reduces the probability of participation of the wife by about 3.5 points; it increases the probability of full-time work by 1.5 points and decreases the probability of part-time work by about 4.5 points.¹⁵

¹⁵ A complication with interpreting this result as a pure means-testing effect is that the shift from UB to SB can entail some, typically small, difference in the maximum level of entitlement, which changed

Garcia (1991), also using a careful specification of the household budget constraint, albeit in an entirely static framework, reports an elasticity of participation with respect to means-tested benefits of -0.36 , and by simulating the effects of means-tested benefits being at different replacement rate levels, shows that the effect of the level of these benefits is significant. It may be that inadequate account is taken of unobserved heterogeneity in the model used, so that the apparent relationship between means-tested benefits and the participation in the labour market of the wives of unemployed men is actually reflecting the relationship between unemployment *per se* and participation. A further possibility is that unobservables are correlated with the type of benefit received, so that SB receipt indicates labour market characteristics of the husband that are shared by his wife. The importance of adequately accounting for unobserved heterogeneity in models of the labour supply of women married to unemployed men is underlined by the problems of interpreting results such as these.

In Davies *et al.* (1992), the income data available were limited, so that the 'twelve month effect' was relied on for evidence of a means-testing effect. Such a twelve month effect was found, with wives of men with unemployment spells longer than a year being less likely to be in employment even after accounting for unobserved as well as observed heterogeneity. However, as pointed out in Section 1.1 the twelve month effect is not a very satisfactory way of establishing the size of the means testing effect. But the fact that there is much means testing entailed in the system also before the twelve month point in an unemployment spell implies that any estimated difference between short spells and long spells in their effect on the wife's labour supply is likely to be an understatement of any means-testing effect, as long as the characteristics that cause a man to have a longer unemployment spell have been accounted for.

Giannelli and Micklewright (1995), analysing German data, also test for the 'twelve month effect' to establish the presence of a means-testing disincentive. First, using a fixed-effects model, they test for the effect of the husband's unemployment on his wife's labour supply and find a negative effect; when the receipt of UA is added to the specification, the effect of unemployment *per se* becomes insignificant, and that of

over the years in which the data were collected in a way that may not be perfectly captured by a linear time trend.

UA significant and negative. This negative effect is not surprising, given the endogeneity of this variable discussed above. In order to test the result, the UA variable is dropped and the duration of the husband's unemployment added to the specification, in the expectation that these will indicate a twelve month effect if a means-testing disincentive is indeed driving the negative UA effect. No such pattern is found. Neither do they find any effect of a means-testing disincentive in their model of transitions between participation and non-participation; even UA receipt does not affect the probability of changing state, despite its endogeneity.

As for the estimation of the effect of SB receipt by a husband on the labour supply of his wife, the results of Kell and Wright (1990) are difficult to interpret. They find that entitlement to SB has a significant negative effect on the probability of a woman participating. However, in none of the models reported is the husband's employment status included in the same specification as the variable for the entitlement to SB. Therefore, this negative coefficient may be reflecting the effect of a husband's unemployment, and hence such effects as the similar characteristics effect, as well as any disincentive effect of means testing.

Finally, the problem of the endogeneity of UA receipt arises in interpreting the results of Dex *et al.* (1995). The results show strong negative effects of means-tested benefits on the participation of the wife for the three countries for which sufficient data are available to estimate their effect - Britain, Ireland and the US. In the cases of Britain and Ireland,¹⁶ the receipt of UI, which is means-tested to a lesser degree than UA also has a large negative effect, which the authors interpret as reflecting the withdrawal of a dependant's allowance if the wife earns more than the amount of the allowance. However, no control for the husband's work status *per se* is included, so that these coefficients must be capturing any complementarity or substitutability of leisure times of husband and wife and similar characteristics in the two of them, as well as a correlation between the receipt of a benefit and participation. The authors emphasize that the difference in the magnitude of the two variables supports the presence of a disincentive effect; however, this may also arise if the groups receiving UI and UA are different in unobservable characteristics, as seems likely.

¹⁶ The Irish benefit system is similar to the British one.

1.4.7 Conclusions

Having reviewed the existing literature on the subject of the labour supply of the wives of unemployed men, it is now possible to draw several specific conclusions as to the issues that have tended to be neglected in previous work, with a view to avoiding these problems in this thesis. The main conclusions are as follows:

- It is important to model the budget constraint beyond the participation margin, as the results obtained for the effect of the husband's unemployment on the probabilities of working high and low hours can differ markedly, as indeed might be expected.
- The specification of appropriate variables to capture the effect of means testing of benefits on the labour supply of the wives of unemployed men is crucial; variables representing benefit receipt are endogenous, and those relying on a 'twelve month effect' of unemployment will tend to underestimate the effect of means testing.
- Accounting for individual heterogeneity and the complementarity of leisure times at the same time as the means testing of benefits is important because of the difficulty in interpreting the results of a model in which one of these factors is omitted.

1.5 The Approach of this Thesis

This thesis uses data from a survey of households headed by unemployed individuals in Britain, conducted in the 1980's, to attempt to explain the lower level of participation in the labour market of the wives of unemployed men. This chapter has introduced the issues motivating this study. It remains to outline the approach taken in the remainder of the thesis.

In Chapter 2, the data used to analyse the reasons for the absence of an AWE in Britain are introduced. These data are from the Living Standards during Unemployment Survey (*LSUS*), from 1983-84. Having described the data and established their suitability for the task in hand, a descriptive analysis of the data is undertaken. Thus, using non-parametric techniques, a preliminary assessment of some explanations of the low participation rates of these women is made, using data on labour force status and attitudes to work of the wives.

In Chapter 3, the construction of variables representing the household income that would apply in different labour market states of the wife is described. These variables will be used in the parametric analysis conducted in later chapters to pinpoint the effect of means testing on women's labour supply, but in Chapter 3, the emphasis is on establishing the link between the means testing of different types of benefits and household income. To do this, both absolute amounts of household income in different labour market states of the wife, and the effective tax rate implied by means testing are examined. The link between women's attitudes to work and the effect of means testing on household income is also examined. Finally, the assumptions underlying the construction of a variable based on household income are discussed.

In Chapter 4, the variables constructed as described in Chapter 3 are used in an econometric analysis of the *LSUS* data, using a model developed by Chamberlain (1980) that accounts for the possibility that unobservable individual-specific fixed effects are important in determining the labour supply of married women. This model, the multinomial fixed effects conditional logit model (FECL) has not been applied to the labour supply of the wives of unemployed men previously, nor, with few exceptions, elsewhere¹⁷ and so a detailed exposition of the model is included in Chapter 4.

In Chapter 5, the variables constructed according to the description in Chapter 3 are again used, but in this case in a dynamic model of labour supply, the Mover-Stayer model. By using a Mover-Stayer framework, it is anticipated that both dependence of observed labour supply on previous labour market experience and heterogeneity in the sample can be controlled for.

Chapter 6 compares the results of the econometric models employed in Chapters 4 and 5, and also places these results in the context of the findings of the work that has been done to date on the subject of the labour supply of the wives of unemployed men, outlined in Section 1.4. A summary of the main conclusions drawn brings the thesis to an end.

¹⁷ The exceptions of which I am aware are Börsch-Supan (1990), Börsch-Supan and Pollakowski (1990) and Rosenzweig and Wolpin (1994).

2. Data Description and Preliminary Analysis

2.1 Introduction

The data source for the present study is the Living Standards During Unemployment Survey (*LSUS*), a British longitudinal household survey conducted in 1983 and 1984. These data have not previously been used to examine the labour supply of the wives of the unemployed, so it is important to describe the data set and discuss its suitability for the analysis of the issues outlined in Chapter 1. To this end, the structure of the *LSU* survey and the nature of the data collected are described in Section 2.2.1 and an outline of the sample selection criteria used given in Section 2.2.2. The advantages and disadvantages of the data set for the analysis of the labour supply of women married to unemployed men are discussed in Section 2.2.3.

The remainder of the chapter entails a descriptive analysis of these data. The descriptive analysis of a data set is useful for three reasons. First, such an analysis can, of itself, provide answers to the questions of interest in a study. Secondly, it can indicate the features of the data whose explanation is most important in more elaborate analytical methods. And thirdly, as well as guiding the choice of modelling strategies, the descriptive analysis of data can indicate likely difficulties in implementing preferred strategies.

In Section 2.3 below, the sample matrices of transitions between labour market states over time are presented. In their raw form, included in Section 2.3.1, these tables describe the extent of 'movement' in the data, indicating whether the data are adequate for the detailed analysis of the labour supply of women married to unemployed men. Sections 2.3.2 and 2.3.3 give transition matrices for various population sub-groups so that a preliminary assessment can be made of the relative importance of the explanations suggested in Section 1.1 for the patterns observed in aggregate data, particularly the lower participation rates of the wives of the unemployed.

Having presented an analysis of the data on labour force transitions, other data collected in the *LSU* survey are utilized. In Section 2.4, a non-parametric analysis of weekly labour force status information is presented which can be used to indicate whether the exhaustion of UB is important to the labour supply of the women surveyed. In Section 2.5, data on the attitudes of the women to participation in the labour force are examined. Section 2.6 concludes.

2.2 The Living Standards During Unemployment Survey

2.2.1 Survey Structure

The *LSUS* surveyed the unemployed and their families directly. The individuals included were randomly selected from those starting to register as unemployed between July 21 and August 20, 1983 in Britain. Thus, the procedure used was to sample from the inflow into unemployment, a strategy which is generally used to eliminate the length bias that results from stock sampling of a population of unemployed. In this case, however, the sample was deliberately truncated by discarding all observations on those whose unemployment ended within three months. The reason for this was that the survey planners were primarily concerned with the effect on living standards of unemployment, and were, therefore, less interested in those unemployed for short periods. The effect of this strategy was that all the household heads sampled had been unemployed for at least three months.

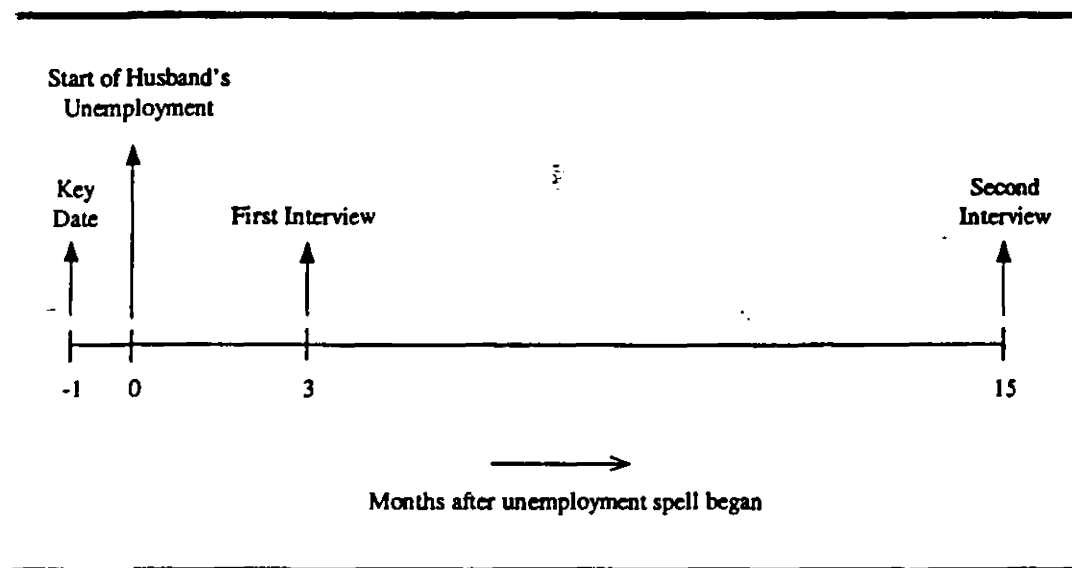
The unemployed individuals included in the survey were all between 20 and 58.5 years of age.¹ No married women who were living with their husbands were included as household heads, possibly because, until 1984, such women were not entitled to claim SB (Stancanelli, 1994).

The structure of the survey is shown in Figure 2.1. At the first interview, held about three months into the unemployment spell, questions concerning the date at which the interview was held and the 'key date', one month before the unemployment

¹ This upper limit was chosen to ensure that the retirement age would not have been reached by the end of the sampling period.

spell began, were asked. The second interview was held a year after the first, and hence fifteen months after the sampled unemployment spell began and sixteen months after the key date. It is important to bear in mind that all sampled individuals were still unemployed at the three month stage, whereas some had obtained employment again by the time of the second interview.

Figure 2.1. The Structure of the Living Standards During Unemployment Survey.



At the first interview, detailed information was collected about the situation of the household at that date and at the key date, one month before the unemployment spell began. The data collected included information for both husband and wife on labour force status, wage and property income, savings and debts, occupation and industry. Similarly detailed questions were asked at the second interview a year later. Also at the first interview, week by week information about labour force status for the previous year was asked of the husband. Further questions about the number of spells of unemployment in the previous five years and whether a job lasting more than a year had ever been held were also asked of the husband, contributing to a picture of his labour market history. None of these latter questions were asked of the wife.

The questionnaire at the second interview contained similar questions to those asked at the first. The main difference between the two interviews was that information on labour force status for each week of the year between the two interviews was asked of the wife as well as the husband at the second interview.

Finally, at both interviews, a series of qualitative questions on the standard of living in the household, travel and job search, the extent of help obtained from friends, families and charities, recreational activities, marital problems, general stress levels and opinions on the effects of unemployment were asked.

Throughout the thesis, the key date, first interview, and second interview, which are the dates for which detailed information was collected, are referred to collectively as the 'principal dates', and where appropriate, the key date is referred to as $t = -1$, the date of the first interview as $t = 3$ and the date of the second interview as $t = 15$.

2.2.2 Selection of a Sample from the *LSUS* data

The *LSUS* contains information on 2925 households. However, some of these households are not relevant to the issue being addressed in this thesis, while others did not respond at the second interview, either because they refused to co-operate with the surveyors, or because they could not be traced. In this section, the groups omitted in order to arrive at the sample used throughout the rest of the thesis are specified.

First, only those households who responded at both interviews are included. 79% of the total sample responded at the second interview; of those who did not, 47% could not be contacted, usually because they had moved home, 51% refused to co-operate and 1% had died. Heady and Smyth (1989) discuss the possible bias from non-response. They conclude that, in terms of family composition, the rate of non-response at the second interview is very similar for all groups, apart from single men aged under 35, who are not included in the final sample used here in any case. But of more concern is the information collected from 83% of those who refused to co-operate at the second interview as to their current economic status; 47% of these were in work, compared to 35% of those who did respond, suggesting that a loss of interest on the part of those who returned to work may have been an important source of non-response. Hence, it seems likely that the sample used for this thesis is different in some respects from the total sample. However, the alternative of using all those who responded at the first interview where possible, regardless of whether they responded at the second interview, would, for the very reason of a possible difference between the two groups, have led to a lack of comparability in assessing the results of models using different

samples. For this reason, I considered the reduction in sample size of 502 households due to this criterion of sample selection to be justified.

A second source of reduction from the 2925 households in the total sample was the exclusion of households not headed by a married man. Thus, all households headed by women are excluded from the analysis. As mentioned above, these households were only included in the survey if the husband was no longer present, in which case, the response of the wife to the husband's unemployment is not relevant. By the same logic, households containing only one person are excluded, as are households containing a married man and his children with no wife present.

Thirdly, only households where the wife was present at all three principal dates are included. This means that households in which the wife was not present at one of the three dates are excluded, as are households where the wives change over the period, so that although the head of household's wife was present at all three dates, she was not the same woman at all three dates. Thus, all results are conditional on the stability of the family; households affected by severe marital difficulties are excluded from the analysis.

The final sample of households headed by unemployed men who were married to and living with the same woman throughout the sample period is 1727 households.

2.2.3 Advantages and Disadvantages of the *LSU* Survey for the Analysis of the Labour Supply of the Wives of Unemployed Men

The single greatest advantage of the *LSU* survey for the investigation of the issues of interest in this thesis is the fact that only households headed by the unemployed were sampled, which means that the sample size is more likely to be large enough to be able to draw statistically valid conclusions. Many of the analyses of the labour supply of women married to unemployed men outlined in Section 1.4 were undertaken using data on the whole population, of which a small proportion is typically unemployed, thus requiring very large sample sizes in order to be able to draw any valid conclusions. Here, since the sub-population sampled is the one of interest, a sample size of 1727 is likely to be adequate. It is interesting to note that this sample size compares favourably with the 692 couples from the Survey of Incomes In and Out of Work (*SIOW*), used by Pudney and Thomas (1992, 1993), and with the 946 wives in the DHSS Cohort

Study of the Unemployed used by Garcia (1989, 1991) in the only other studies on this topic which analyse a sample of households headed by unemployed individuals.

A second advantage of this data set is that it is from a panel survey, and more particularly that the survey period is reasonably long. Because of its length, the reaction of the women surveyed to several events may be observed. For all women, their husbands become unemployed between the key date and the first interview. However, some husbands become employed again in the year between the two interviews; indeed, they may be employed and unemployed several times between these two dates. Thus, the reaction of a wife to her husband's re-employment may be observed.

Moreover, for men who do not exit their sampled unemployment spell by the date of the second interview, but who qualify for UB, the exhaustion of their entitlement to UB and the consequent change in the means-testing structure of household income during the year between the two interviews provides another event in the household to which their wives may react. Again, this compares favourably with the data set used by Pudney and Thomas, in which the final interview is conducted about nine months after the husband first signed on to the unemployment register, and therefore before the exhaustion of UB.

There are, however, several features of the data which are disadvantageous. The most important deficiency in the survey is the fact that no data on education levels or experience in the labour force were collected for any household members.² It is usually necessary in analyses of the labour supply of married women to impute the wage which non-working women would earn if they were working, a task which is rendered difficult by the absence of an education variable, since it is the most direct measure of human capital. I return to this point in Section 3.2. Another important demographic variable that was not collected is the race of the household members, which is usually found to be important to the labour supply of wives in British studies.

A second disadvantage of the survey is that weekly labour force participation details were not collected for the wives of the household heads for the year before the first interview. This means that between the start of the husband's spell of unemploy-

² Data on the husband's experience of *unemployment* were collected, as mentioned in Section 2.1.

ment and the first interview, there are no weekly data for the wives, making the use of the weekly data that were collected problematic. The use of these data is discussed in greater detail in Section 2.4.

Thirdly, the exclusion of all households headed by individuals whose unemployment lasted for less than three months is problematic for the interpretation of the results, since they strictly apply only to those who are unemployed for more than this length of time. However, this aspect of the sampling strategy has one advantage. It is well known that data on unemployment payments are unreliable in the initial signing on period, because the appropriate level of payment is not always immediately obvious to the administration. Narendranathan *et al.* (1985) actually discard all individuals whose unemployment spell end within four weeks to deal with this problem. This particular measurement problem is, therefore, not one that needs to be considered here.

A further, more minor disadvantage of the survey is its timing. The interviews were conducted in 1983 and 1984, at a time when both the level of unemployment, and the proportion of it that was long-term, increased dramatically in the UK, and indeed in other countries (OECD, 1993). Between 1981 and 1983, the proportion of unemployment that lasted for over a year increased from less than 30% to almost 50%. This is a disadvantage because if women update their expectations of the duration of their husbands' unemployment on anything other than a Rational Expectations basis - for example, with a partial adjustment mechanism - then more women will make mistakes in calculating their best response to their husbands' unemployment.

Finally, a feature of the data set that may be a disadvantage should be mentioned: at the three principal dates, labour force status is collected in four hours ranges - full-time work, part-time work of more than ten hours per week (high part-time hours), part-time work of less than ten hours per week (low part-time hours), and no work.³ This method of grouping the variable of primary interest in this survey is certainly a disadvantage in some ways. First, it makes the calculation of precise hourly wage rates impossible, a point that I return to in Section 3.2. Secondly, it makes it im-

³ Full-time work appears to have been self-defined, although interviewers were instructed to count two part-time jobs which totalled more than thirty hours per week as a full-time job, so it may be that an *ad hoc* adoption of a 'more than thirty hours' definition was in operation.

possible to estimate a model of the type used by Garcia (1989, 1991), where an explicit utility index is specified and optimization based on the comparison of utility levels assumed, as described in Section 1.4. Thirdly, as regards the particular choice of groups, the fact that no distinction is made between those not working by choice and those constrained in their labour market supply behaviour is a drawback for investigating the possibility, mentioned in Section 1.1, that local labour market conditions affecting both spouses may be an important determinant of the labour supply of women married to unemployed men.

On the other hand, it has been argued that the grouping of hours is a valid way of dealing with the presence of demand-side constraints on the hours that may be worked; for institutional or other reasons, firms may not offer a continuum of hours, so the hours distribution may be bunched at a few points.⁴ However, even if a decision were taken to group hours in the analysis of the labour supply of these women, the grouping chosen might not necessarily be the one used by the *LSUS* surveyors.

2.3 Preliminary Analysis: Transition Matrices

2.3.1 Transition Matrices: All Individuals

The *LSUS* data show that, as regards the situations at the three principal dates for which information is collected, 466 women (27%) change from one of the four status categories (full-time work; part-time work of more than ten hours per week; part-time work of less than ten hours per week; no paid work) to another between two of these principal dates. 85 (4.9%) change their status twice; for 45 of these (2.6%) the second change is back to their original status; so they change status between the key date and the first interview, only to make a transition back to their original status by the second

⁴ This point is discussed further in Section 3.7.

interview. Again, this level of transitions compares favourably with the *SIHOW* used by Pudney and Thomas (1993), where about 15% of individuals record transitions.⁵

Tables 2.1 and 2.2 show the patterns of movement between the key date and the first interview, and between the first interview and the second. In these tabulations, the highlighted figures on the diagonal indicate individuals who are in the same state at both dates; those to the left of the diagonal are working more at the second date than at the first, while those to the right of the diagonal are working less at the second date than previously.

The first point that can be made about the information in these tabulations is that the employment rate of these women before their husband's unemployment began was 36%. According to the 1983 General Household Survey, the rate of employment prevailing among all married women in the UK in that year was 57% (OPCS, 1983), so the participation of the wives surveyed in the *LSUS* is clearly lower than average.

Table 2.1. Transitions between key date and first interview. Percentage of total sample in brackets.

Job Status at $t = -1$	Job status at $t = 3$				Total
	Full-Time	Part-Time, > 10 hours	Part-Time, < 10 hours	None	
Full-Time	227 (13.5)	17 (1.0)	1 (0.1)	54 (3.2)	299 (17.8)
Part-Time, > 10 hours	2 (0.1)	181 (10.8)	12 (0.7)	42 (2.3)	237 (13.9)
Part-Time, < 10 hours	1 (0.1)	6 (0.4)	56 (3.3)	9 (0.5)	72 (4.3)
None	12 (.7)	24 (1.4)	13 (0.8)	1023 (60.9)	1072 (63.8)
Total	242 (14.4)	228 (13.6)	82 (4.9)	1128 (67.1)	1680 (100.0)

As to the transitions themselves, Table 2.1 indicates that, initially at least, the forces inducing the women concerned to work fewer hours - which may be because of

⁵ These transitions levels are not strictly comparable, since the definitions of states in the *SIHOW* and in the *LSUS* are different: in the former survey, the states are defined as full-time work, part-time work, no paid work and unemployment.

disincentive effects or a labour market shock affecting both partners - seem to be stronger than the added-worker effects. 135 women (8%) are working fewer hours at $t = 3$ than they were at $t = -1$, while 58 (3%) are working more hours.

Table 2.2. Transitions between first and second interviews. Percentage of total sample in brackets.

Job Status at $t = 3$	Job status at $t = 15$				Total
	Full-Time	Part-Time, > 10 hours	Part-Time, < 10 hours	None	
Full-Time	201 (11.7)	8 (0.5)	1 (0.1)	37 (2.2)	247 (14.4)
Part-Time, > 10 hours	24 (1.4)	156 (9.1)	14 (0.8)	35 (2.0)	229 (13.4)
Part-Time, < 10 hours	5 (0.3)	17 (1.0)	34 (2.0)	27 (1.6)	83 (4.8)
None	38 (2.2)	62 (3.6)	38 (2.2)	1016 (59.3)	1154 (67.4)
Total	268 (15.6)	243 (14.2)	87 (5.1)	1115 (65.1)	1713 (100.0)

The cross-tabulation of the states occupied at $t = 3$ and $t = 15$ given in Table 2.2 shows a reversal of this pattern, however. More individuals have changed state, as would be expected given the longer time available. But the number of transitions towards fewer hours of work is very similar to that between the key date and the first interview, despite there being more time available; a further 122 women (7%) work fewer hours at the second interview than at the first interview, compared to 135 (8%) working fewer hours at the first interview than at the key date. Movement towards working more hours shows a much greater increase, however; at the date of the second interview, 184 (11%) are working more than they were at the first interview, compared to the 58 at the date of the first interview working more than previously. It seems that adjustment towards paid work is slower than from work to non-work. This is reasonable, as it is likely to take more time to find a job than to quit a job. This suggests that adjustment delays are important, and more important for an added-worker effect than for a disincentive effect.

Notably, however, the pattern does not appear to support a conclusion that the increased means testing applicable after a year of unemployment increases the disin-

centive effect. These are, of course, just head-count figures, and it may be that for those women to whose income the means test began to apply at this stage, the disincentive effect did indeed have an effect, but that this was counteracted by a move back to work by those whose husbands became employed before the second interview.

Table 2.3 shows the changes in states occupied between the key date, before the husband's unemployment began, and the second interview. As expected given the content of Tables 2.1 and 2.2, over the entire period, the disincentive effect⁶ is still stronger than the added-worker effect.

Table 2.3. Transitions between key date and second interview. Percentage of total sample in brackets.

Job Status at $t = -1$	Job Status at $t = 3$				Total
	Full-Time	Part-Time, > 10 hours	Part-Time, < 10 hours	None	
Full-Time	203 (12.1)	25 (1.5)	4 (0.2)	65 (3.9)	297 (17.7)
Part-Time, > 10 hours.	20 (1.2)	141 (8.4)	19 (1.1)	56 (3.4)	236 (14.1)
Part-Time, < 10 hours.	5 (0.3)	15 (0.9)	24 (1.4)	28 (1.7)	72 (4.3)
None	33 (2.0)	59 (3.5)	40 (2.4)	936 (56.0)	1068 (63.8)
Total	261 (15.6)	240 (14.3)	87 (5.2)	1085 (64.9)	1673 (100.0)

Throughout the discussion above, the term 'added worker' has been used to mean those working more hours at a particular point than previously. In fact, most of the increases in hours of work do indeed come from former non-participants beginning to participate rather than those participating before the husband's unemployment began increasing their hours of work. Thus, most of the added workers fit into the usual meaning of the term. The more general point here is that most of the transitions are between working and non-working states, in both directions.

⁶ The movement to fewer hours may entail a local labour market shock, or indeed strong complementarity of leisure times, rather than a disincentive effect.

The fact that so many of the transitions are between working and not working means, however, that many of the other cells are very sparse. The lack of transitions is particularly noticeable between full-time work and working low part-time hours. Other cells of the transitions matrices are also quite sparse, particularly for transitions between the key date and the first interview, such as from high part-time hours to full-time work, and from low part-time hours to both high part-time hours and to no work. The implications of small cell sizes for the econometric analysis of the data are discussed in Section 5.2.2.

Finally, it is interesting to compare the level of transitions among these women with that in the general population of married women in Britain. Data from the Luxembourg Employment Study (LES), which date from 1989 for the UK, show that of married women not working in 1988, 10.4% were working in 1989; 2.5% worked full-time, whilst 7.9% worked part-time. This compares with a rate of entry into full-time work between the first and second interviews in the *LSUS* data of 3.3%, and into part-time work of 8.7%, giving a total entry rate of 12%, which is similar to the general rate. However, for the rate of entry to work between the key date and the first interview, 1.1% of women not working at $t = -1$ are working full-time at $t = 3$, and 3.5% are working part-time. If annualized, these figures indicate a rate of entry to full-time work of 3.4% and of 10.4% to part-time work. The latter figure is clearly higher than for the general population.

More striking however is the comparison of rates of exit from the labour market. The LES data show that 7.8% of married women in Britain who were working in 1988 were not in the labour force in 1989. This compares with a rate of exit from the labour force of women in the *LSUS* data of 17.7% between the first and second interviews, which is clearly significantly higher. Even more remarkable is the fact that between $t = -1$ and $t = 3$, and hence in the space of four months, 17.3% of working women left employment, which rate, if annualized, is equivalent to a rate of exit of 51.8%. Thus, it does seem that a woman's husband becoming unemployed tends to cause a re-consideration of the labour supply decision, making it much more likely that a labour market transition will be observed. Of course, given that the *LSUS* and LES apply to different years, changes in macro-economic conditions may be affecting the comparison of transitions made; in 1989, the level of unemployment was relatively low,

at 7%, and had been falling steadily since 1984, whereas in 1983, the unemployment rate was over 12%, and had been rising since the late 1970's. These differences might be expected to produce more transitions out of employment in the *LSUS* data than in the *LES* data, and more transitions into employment in the *LES* data than in the *LSUS* data. Thus, it may be that the comparison used makes the difference in exits greater and that in entries lower than if both sets of data applied to the same year.

2.3.2 Transition Matrices: By Initial Job Status

It was noted in the previous section that there was some evidence of adjustment delays in moving to paid work from outside the labour force. This suggests that the timing of transitions is affected by the state occupied initially; it is also likely that the destination state is affected by the initial state. Tabulations of the data are used to shed some light on these points in this section.

Tables 2.4, 2.5, 2.6 and 2.7 show the detailed breakdown of transitions by a woman's job status prior to her husband's sampled unemployment spell beginning. In each case, the highlighted figure shows those in the same state at all three principal dates, the 'stayers', while those represented in the other cells are individuals who make a transition at some stage during the sample period.

Table 2.4. Transitions between first and second interviews for women working full-time at the key date.

Job Status at $t = 3$	Job status at $t = 15$				Total
	Full-Time	Part-Time, > 10 hours	Part-Time, < 10 hours	None	
Full-Time	188 (63.3)	8 (2.7)	1 (0.3)	28 (9.4)	225 (75.8)
Part-Time, > 10 hours	4 (1.4)	10 (3.4)	0 (0.0)	3 (1.0)	17 (5.7)
Part-Time, < 10 hours	0 (0.0)	0 (0.0)	1 (0.3)	0 (0.0)	1 (0.3)
None	11 (3.7)	7 (2.4)	2 (0.7)	34 (11.5)	54 (18.2)
Total	203 (68.4)	25 (8.4)	4 (1.4)	65 (21.9)	297 (100.0)

Table 2.5. Transitions between first and second interviews for women working part-time, >10 hours at the key date.

Job Status at $t = 3$	Job status at $t = 15$				Total
	Full-Time	Part-Time, > 10 hours	Part-Time, < 10 hours	None	
Full-Time	2 (0.9)	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.9)
Part-Time, > 10 hours	14 (5.9)	133 (56.4)	12 (5.1)	22 (9.3)	181 (76.7)
Part-Time, < 10 hours	2 (0.9)	2 (0.9)	6 (2.5)	2 (0.9)	12 (5.1)
None	2 (0.9)	6 (2.5)	1 (0.4)	32 (13.6)	41 (17.4)
Total	20 (8.5)	141 (59.8)	19 (8.1)	56 (23.7)	236 (100.0)

Table 2.6. Transitions between first and second interviews for women working part-time, < 10 hours at the key date.

Job Status at $t = 3$	Job status at $t = 15$				Total
	Full-Time	Part-Time, > 10 hours	Part-Time, < 10 hours	None	
Full-Time	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.4)
Part-Time, > 10 hours	1 (1.4)	5 (6.9)	0 (0.0)	0 (0.0)	6 (8.3)
Part-Time, < 10 hours	2 (2.8)	10 (13.9)	24 (33.3)	20 (27.8)	56 (77.8)
None	1 (1.4)	0 (0.0)	0 (0.0)	8 (11.1)	9 (12.5)
Total	5 (6.9)	15 (20.8)	24 (33.3)	28 (38.9)	72 (100.0)

Several patterns are evident from the data. First, the point made above about the extent to which transitions are dominated by movements between working and not working, rather than among working states is underlined by these tables. In each one, the cells which are most occupied are those entailing combinations of the state occupied at $t = -1$ and 'none'. Thus, for example, Table 2.4 shows that apart from those

who do not change state at all during the survey period, the most common transitions by those working full-time at $t = -1$ are to full-time work at $t = 3$ and no work at $t = 15$, and to no work at both $t = 3$ and $t = 15$. Because making two transitions over the survey period is relatively rare other cells are typically sparse.

Table 2.7. Transitions between first and second interviews for women *not working* at the key date.

Job Status at $t = 3$	Job status at $t = 15$				Total
	Full-Time	Part-Time, > 10 hours	Part-Time, < 10 hours	None	
Full-Time	4 (0.4)	0 (0.0)	0 (0.0)	8 (0.8)	12 (1.1)
Part-Time, > 10 hours	5 (0.5)	7 (0.7)	2 (0.2)	10 (0.9)	24 (2.3)
Part-Time, < 10 hours	1 (0.1)	5 (0.5)	3 (0.3)	4 (0.4)	13 (1.2)
None	23 (2.2)	47 (4.4)	35 (3.3)	914 (85.6)	1019 (95.4)
Total	33 (3.1)	59 (5.5)	40 (3.8)	936 (87.6)	1068 (100.0)

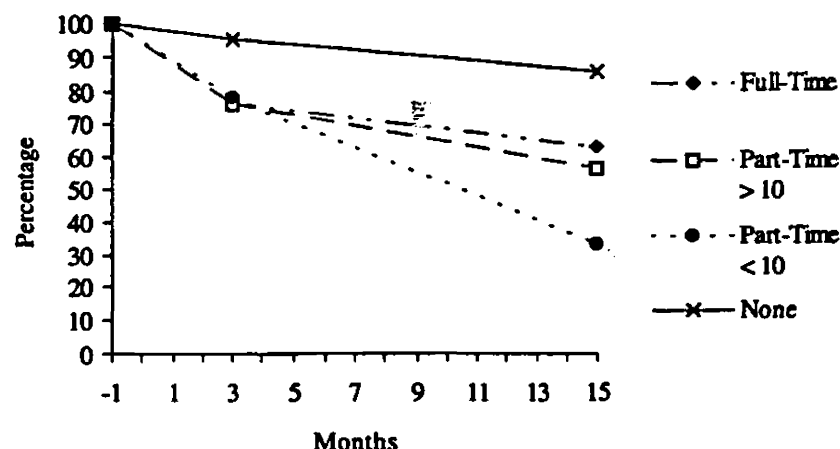
A second point is that the proportion of the sample who stay in the same state throughout the sample period - the 'stayers' - varies significantly according to the initial state occupied. Inspection of Table 2.1 shows that 76% of those working full-time before their husbands' unemployment began are in the same state three months after the spell began. Similar figures for stayers in each group apply to those who are working part-time initially. The figure for those not working at first is substantially higher, however; 95% of them are in the same state four months after the key date. This might be explained by the argument that it takes longer to find a job than to quit a job, or even to find another job.

Yet the pattern remains one year later, when it might be expected that such adjustment delays are less relevant.⁷ Tables 2.4 to 2.7 show that fifteen months after their husbands' unemployment began, women who were not working before their hus-

⁷ At the fifteen month stage many women are facing another situation - being affected by a means test, or husbands having exited unemployment - to which they must adjust.

bands became unemployed still tend to be stayers to a greater extent than other women - 86% as opposed to 63% of initial full-timers, 56% of part-timers who worked more than ten hours, and just one third of part-timers working less than ten hours per week initially. This point is emphasized by Figure 2.2.

Figure 2.2. Proportion of those initially in each state who are still in that state at $t = 3$ and $t = 15$.



Although a greater proportion of women working low part-time hours at $t = -1$ make transitions than any other group, the fact remains, as mentioned in Section 2.3.1, that in absolute terms, very few transitions are made by women working low part-time hours.

2.3.3 Transition Matrices: By Heterogeneous Groups

The possibility was mentioned in Section 2.3.1 that differences in the transition rates between those working at the key date and those not working at that point arise because of greater adjustment delays for those entering the labour market. Another possible explanation is that the type of woman who does not work is basically different to the type of woman who does work. In this section, some evidence for this argument is sought, using the proposition that the labour market characteristics of a man may be reflected in his wife. Tables 2.8 and 2.9 allow a comparison of women whose husbands are unemployed for more than fifteen months and those whose husbands have returned to work by the second interview.

Table 2.8. Transitions between the key date and the second interview for women whose husbands had not left the sampled unemployment spell by the second interview.

Job Status at $t = -1$	Job status at $t = 15$				Total
	Full-Time	Part-Time, > 10 hours.	Part-Time, < 10 hours.	None	
Full-Time	36 (5.4)	9 (1.4)	2 (0.3)	21 (3.2)	68 (10.2)
Part-Time, > 10 hours.	2 (0.3)	38 (5.7)	7 (1.1)	26 (3.9)	73 (10.9)
Part-Time, < 10 hours.	0 (0.0)	4 (0.6)	12 (1.8)	13 (1.9)	29 (4.3)
None	7 (1.1)	9 (1.3)	11 (1.7)	470 (70.5)	497 (74.5)
Total	45 (6.8)	60 (9.0)	32 (4.8)	530 (79.5)	667 (100.0)

Table 2.9. Transitions between the key date and the second interview for women whose husbands had left the sampled unemployment spell by the second interview.

Job Status at $t = -1$	Job status at $t = 15$				Total
	Full-Time	Part-Time, > 10 hours.	Part-Time, < 10 hours.	None	
Full-Time	167 (16.6)	16 (1.6)	2 (0.2)	44 (4.4)	229 (22.8)
Part-Time, > 10 hours.	18 (1.8)	103 (10.2)	12 (1.2)	30 (3.0)	163 (16.2)
Part-Time, < 10 hours.	5 (0.5)	11 (1.1)	12 (1.2)	15 (1.5)	43 (4.3)
None	26 (2.6)	50 (5.0)	29 (2.9)	466 (46.3)	571 (56.8)
Total	216 (21.5)	180 (17.9)	55 (5.5)	555 (55.2)	1006 (100.0)

The first point that should be made about these tables is that even before their husbands' sampled unemployment spells began, just 25.5% of women whose husbands were still unemployed at the second interview worked, as opposed to 43.2% of those whose husbands were employed again by the second interview. The most obvious explanation for this is that the couple share characteristics which make both his re-

employment and her doing paid work at any stage less likely, as suggested in Section 1.1.

One other possibility is that those men who tend to have longer unemployment spells also have more frequent spells, so that the wife's non-participation prior to the sampled spell is a long-term response to her husband's labour market behaviour. However, this suggestion is not supported by the data. Those men who exit their sampled unemployment spell before the second interview are actually slightly more likely to have been unemployed in the previous five years, and more likely to have had more spells of unemployment during that time, the correlation between exiting the sampled spell and having been unemployed in the previous five years being 0.06, and that between exiting and the number of spells of unemployment 0.08.

A second point that can be made about these tables is that women whose husbands are longer-term unemployed are more likely to be stayers; 83.4% of women whose husbands are still in their sampled unemployment spell fifteen months after it began stay in the same state throughout the sample period, while 74.4% of women whose husbands are not do not change status.⁸ This is consistent with the pattern established above that women who are not employed prior to the start of their husbands' spells also tend to be stayers to a greater extent.

Thirdly, women whose husbands have exited the sampled spell by the second interview are substantially more likely to be added workers; 13.8% of these women work more hours at the second interview than initially, compared to just 5% of women whose husbands are longer-term unemployed. About the same proportions of each work less hours than initially, which means that the lower level of movement among those whose husbands are unemployed for longer comes almost entirely from a lower level of added-worker behaviour. A difference in the extent of movement away from work might be expected to hold between these two groups, since all of those whose

⁸ Of course, not all men who exit their sampled unemployment spell do so to full-time employment; of the 1038 men who did exit, 79% of them did so to full-time work. For the remainder who exited, but not to full-time work, 8% did so to 'sick and out of work', 4% did to 'part-time work, more than ten hours' and 3% left to 'government schemes'. Interestingly, the proportion of women whose husbands exited to full-time work and who are stayers is lower again: 69% of them never change status, supporting the 'similar characteristics' hypothesis.

husbands did not exit unemployment are subject to means-tested benefits by the time of the second interview. The fact that this is not the case suggests that the disincentive effect arising from means testing may not be very important.

It is interesting to note the outcome of similarly disaggregated cross-tabulations between states at the key date and at the first interview, when *all* husbands are unemployed. The data show no statistically significant difference in the transition matrices according to the eventual length of the husband's unemployment spell: 90.9% of those whose husbands' spells last over fifteen months are in the same state at $t = -1$ and $t = 3$, compared to 86.9% of those whose husbands' spells are eventually shorter. Moreover, the levels of movement towards and away from work are similar for both groups. Thus, the wives of men with shorter unemployment spells have a higher level of added-worker behaviour between the first and second interviews, but not in the first three months of unemployment, which fact militates against an explanation of the differences that is based on the importance of similarities between spouses, since in this case, the differences would be expected to be observable even before the exit from the sampled unemployment spell occurred.

A similar exercise was carried out in comparing those women whose husbands were eligible for UB at the first interview and those whose husbands were not. UB might be expected to be an indicator of a man's type, since only those with reasonably stable employment histories qualify for UB. Again it was noted that 40% of women whose husbands were eligible for UB when they became unemployed were working at the key date, while only 27% of those whose husbands did not qualify for UB worked, indicating a difference in a woman's 'type' according to her husband's UB eligibility.

On the other hand, the proportions of both groups who stay in the same state during the sample period, and the proportions moving towards both more and fewer hours of work, are very similar. This is interesting because here, similar characteristics do not seem to affect whether the wives are movers or stayers, which may be due to the lower level of means testing associated with UB receipt.

2.4 Preliminary Analysis: Weekly Data

2.4.1 The Hazard of Making a Transition

One of the features of the *LSUS* data, mentioned above, is that weekly information on each wife's labour force status was collected for the year between the first and second interviews. During that time, some women's husbands returned to work, and others' entitlement to UB was exhausted. In this section, the weekly data are inspected for an indication of the importance of this latter fact; in particular, evidence that women make transitions to a greater extent around the time of UB exhaustion, particularly from working states to non-work, is sought. From this preliminary investigation of the weekly data, the advantages and disadvantages of using them can be established, and in Section 2.4.2 their suitability for further analysis is discussed.

To check for a UB exhaustion effect, a non-parametric method, life-table estimation of the hazard of making a transition, is used. Transitions both from non-work to work, and from work to non-work are analysed. Non-parametric methods of estimation are useful for the inspection of data because they impose no functional form, and thus allow the interesting features of the data to emerge. In life-table estimation, the probability of making a transition in an interval of time $I_i = [a_{i-1}, a_i]$, conditional on not having made a transition before then, θ_i , is estimated from

$$\hat{\theta}_i = \frac{D_i}{N_i - M_i/2} = \frac{D_i}{\bar{N}_i} \quad (2.1)$$

(Lawless, 1982), where D_i is the number of relevant transitions made in interval I_i , N_i is the number who have not yet made a transition at the start of the interval, and M_i is the number of observations withdrawn during the interval because of censoring.⁹ θ_i is known as the hazard rate. Usefully, confidence intervals can be estimated for the hazard at each interval, using Greenwood's formula for the variance of the hazard rate

$$\hat{V}(\hat{\theta}_i) = \frac{\hat{\theta}_i(1 - \hat{\theta}_i)}{\bar{N}_i} \quad (2.2)$$

⁹ The adjustment in the denominator for censored observations amounts to an assumption that observations withdrawn during I_i were at risk for half the interval.

Presenting the data in this way is more sophisticated than a plot of the number making their first transition at a particular time, since it takes account of the fact that if the first transition has already been made, it cannot be made again.

Clearly, however, this way of representing the data does not exploit some features of the information contained in the *LSUS*. First, it uses only the first transition made by each woman, while the women sampled make up to thirteen transitions between the first and second interviews. Secondly, it does not distinguish between different working states; full-time work and both part-time work states are treated as one. This treatment implies that there is no difference between the hazard of making a transition from full-time work and the hazard of making a transition from part-time work. This is clearly a strong assumption, but there are too few transitions between individual working states and other states on a weekly basis to draw any interesting conclusions about the effect of UB exhaustion on the hazard of making more narrowly defined transitions.

Figure 2.3. Life-table estimates of the hazard of making a transition from not working to working for women whose husbands qualify for UB at the first interview and have not exited their unemployment spell by the second. 95% confidence intervals shown.

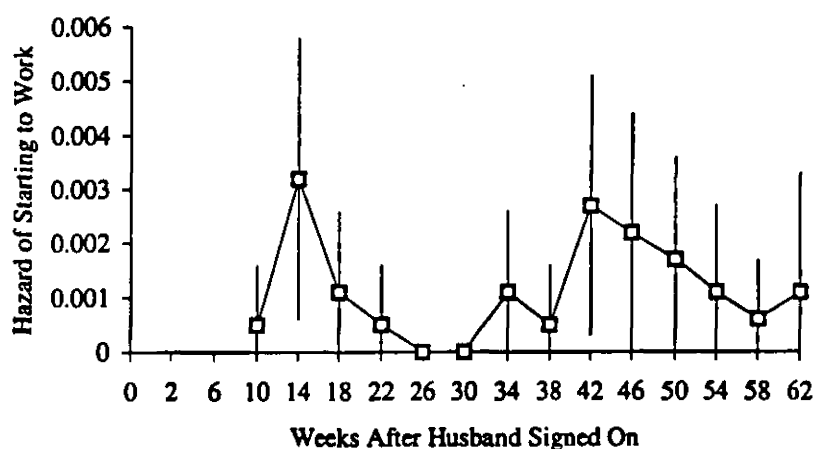


Figure 2.3 shows life-table estimates of the hazard of starting to work, with confidence intervals, for those women whose husbands qualify for UB and are still in their sampled unemployment spell at the second interview; thus, the women represented in this graph are all married to men to whom UB exhaustion is relevant. The hazard rate has been graphed against the number of weeks that have passed since the woman's husband first signed on, rather than against specific calendar dates, so that

the 52 week point indicates the point of UB exhaustion for all husbands. The weeks are grouped so that each interval contains four weeks. The confidence intervals are large because of the small number of women involved: 472 women are married to UB qualifiers who do not exit their sampled unemployment spell, of whom just 29 make transitions into one of the working states, whilst even fewer, 10, make transitions from working into non-working. Thus, the hazard of making a transition out of employment is uninteresting, as in no case is the estimate of the hazard significantly different from zero.

Given such large confidence intervals, the hypothesis cannot be rejected that the hazard rate is constant over the duration of the husband's unemployment spell. There does appear to be an increase in the hazard at the 40 week stage, but there is a sharp drop in it immediately afterward, which makes it unlikely that this is, in fact, a UB exhaustion effect. When a likelihood ratio¹⁰ (*LR*) test is carried out on the hypothesis that there is no difference in the hazard between the group used above whose husbands do not exit their unemployment spell and are entitled to UB, and the group of those whose husbands do not exit their spell and are *not* entitled to UB, the hypothesis is comfortably accepted, with a probability that the hypothesis is correct of 0.4. Thus, conditional on a woman's husband not exiting his unemployment spell, there is no statistical difference, in terms of the hazard of making a transition from not working to working, between those whose husbands qualify for UB and those whose husbands do not.

Figure 2.4 shows the life-table graphs of the hazard of beginning to work for all women, according to whether their husbands are entitled to UB or not. The husbands of women in both these groups may have exited unemployment by the end of the period; indeed they may have moved between employment and unemployment several times. From an inspection of the plots, it appears that there is no systematic difference in the hazard rate according to qualification for UB. This is confirmed by the results of the *LR* test of the differences between groups: the hypothesis of homogeneity between the two groups is accepted at usual levels of confidence.

Figure 2.4. Life-table estimates of the hazard of making a transition from not working to working, according to whether husband qualifies for UB or not.

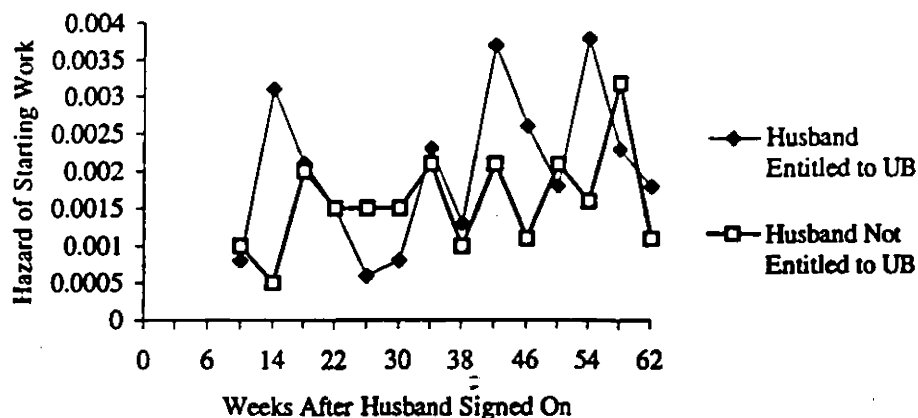
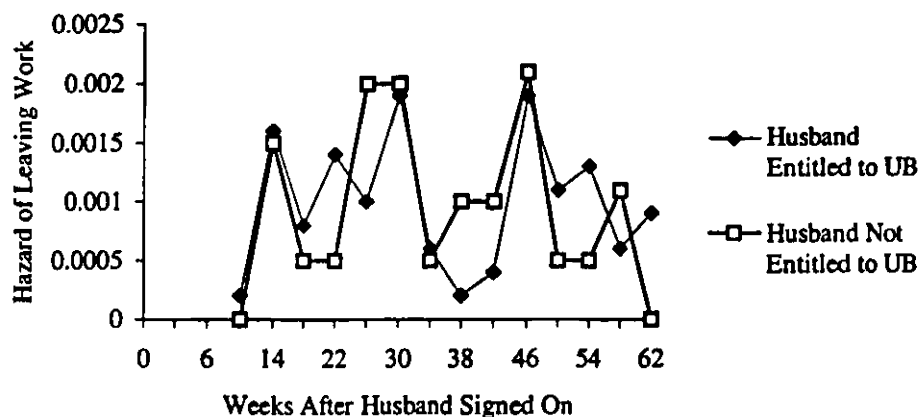


Figure 2.5. Life-table estimates of the hazard of making a transition from working to not working, according to whether husband qualifies for UB or not.



The above figures show no evidence of an effect of the exhaustion of a husband's UB on his wife's probability of making a transition. There are several possible reasons for this. One is that life-table estimation takes no account of individual heterogeneity, beyond one or two grouping criteria at a time; within these groups, the individuals are assumed to be homogeneous. Perhaps if enough characteristics could be held constant for a given life table, a pattern indicating a UB exhaustion effect would

¹⁰ A Likelihood Ratio test is an asymptotic hypothesis test based on the statistic $LR = -2(\ln \hat{L} - \ln \hat{L})$, where \hat{L} and \hat{L} are the log-likelihood functions evaluated at the restricted and unrestricted estimates

emerge. A second explanation is that decisions to make a transition, once made, take time to implement, particularly for transitions towards working states. On the other hand, if UB exhaustion is anticipated, then the expected adjustment time can be taken into account. Nonetheless, the combined uncertainties of the time required to effect any decision to make a transition and the probability that a woman's husband will remain unemployed long enough to be affected by UB exhaustion make a distinct exhaustion effect difficult to detect. A third possibility is that the women in the sample perceive no substantial difference between the effect of the means test applied to their earnings under SB and the limited means test applied under UB.

Similar life-table-based analyses were carried out according to grouping criteria other than the husbands' eligibility for UB. The hazard functions were statistically non-homogeneous across groups when the data were categorized according to whether the husbands exited their sampled unemployment spells before the second interview or not, according to the wife's job status at the key date, and by age groups. Although these grouping criteria certainly captured heterogeneity in the sample, in no case did the graphs of the life-table estimates of the hazard rate show a clear pattern over time.

2.4.2 The Value of the Weekly *LSUS* data

The preceding section entailed a preliminary examination of weekly transitions by the women in *LSUS*. Here, the advantages and disadvantages of the further use of these data are discussed.

The main advantage of using the weekly data is that it is certainly true that the data for the principal dates do not fully reflect the extent of transitions towards and away from work in the sample. There are 65 women who make transitions among the four main labour market states between $t = 3$ and $t = 15$, but who are in the same states at the first and second interviews, and who therefore do not register as having made any transition in, for example, Table 2.2. Of these 65 women, 12 make one transition,¹¹ 39 make two transitions, 7 make three transitions, 5 make four transitions and

respectively. This statistic is distributed as χ^2_q , where q is the number of restrictions imposed.

¹¹ The fact that these women register as being in the same state at two successive principal dates despite having made just one transition is discussed below.

2 make six transitions between the two principal dates. This leads to a very different picture of labour market behaviour than would be gained from inspecting only the data from the principal dates. Because of the small intervals of time used, the weekly data yield a much truer picture of labour market activity than do the principal dates data.

However, there are several problems with using these data, over and above those that exist for the whole data set, discussed in Section 2.2.3, that should be taken into consideration. First, the questions asked about the weeks between the two interviews involved only information on job status. No data on the wage corresponding to any new job were collected, for example, unless the individual was still in that job at the date of the second interview, in which case the transitions are registered in the principal date information in any case. So estimating the role of economic incentives in determining these transitions is difficult.

Secondly, the problem of the reliability of information collected retrospectively arises. When questions are asked about the past, the issue of difficulties on the part of the respondents in remembering details arises. This problem may not be very severe for the *LSU* survey, compared to others that go back over many years, but the fact that data is sought on a week-by-week basis makes inaccuracies more likely. Evidence of this exists for the *LSUS*, to the extent that there are inconsistencies between the data given about job status at the first interview and at the second. The weekly data collected began in the week after the first interview; 7% of women claim, during the second interview, to have been in a different state in the week after the first interview than they said they were in at the time of the first interview. It is possible that there was a very high rate of transitions during that week, but it is unlikely, particularly given the fact that the proportion of women giving a different job status for the week before the second interview and the date of the second interview is just 1%. This type of inconsistency between the weekly data collected at the second interview for the time around the first interview and the principal date information for the first interview is responsible for 8 of the 12 cases cited above who were in the same state at both the first and second interviews, but who claimed to have made just one transition according to the weekly data.

A third problem, also already mentioned, is the fact that weekly data are not collected from the time of the husband's first signing on, or before then, but only from

the date of the first interview. In Section 2.3.1, it was pointed out that the level of transitions between the key date and the first interview is much higher than that between the two interviews, so the detail of the timing of a significant number of transitions is not available in any case.

Moreover, the point emerged in the preceding section that there appeared to be no very striking benefit from using the weekly data. The preliminary analysis of the weekly data confirmed that there was no clear UB exhaustion effect, and that grouping data according to either the job status occupied before the sampled unemployment spells began or according to whether the husband exited that unemployment spell within fifteen months indicated that these were important indicators of heterogeneity in labour market behaviour. Both these points had already been established in Section 2.3, using the data for the principal dates, so the additional insights gained from using these data appear to be limited.

For these reasons, the remainder of the thesis entails an analysis of the information collected at the principal dates.

2.5 Preliminary Analysis: Data on Attitudes

Both interviews of the *LSU* Survey include a question, asked of the wife, on whether having an unemployed husband makes it more or less sensible for her to have a job, and why. The question is put only if the husband is signing on at the time, so all wives are asked at the first interview, but only 927 are asked at the second interview. Of those asked at the second interview, some are women whose husbands have exited the sampled unemployment spell, but who have become unemployed again.

These questions are interesting for the information they provide on attitudes to work, since one of the reasons that the wives may choose for thinking that a husband's unemployment makes it less sensible to work is that it is not worthwhile financially, so the question can give a good indication of the extent of the perceived disincentive effect of the means testing of benefits.

Table 2.10 summarizes the answers to the question about whether a woman's husband's unemployment makes it more or less sensible for her to work. The second

column shows the replies given at the first interview by those who answered also at the second interview, so those whose husbands were working at the second interview are excluded. This column is included in order that the responses of those answering at both interviews may be compared.

Table 2.10. Wives' views on paid work at the first and second interviews. Percentages of total in brackets.

Does Unemployment of Husband Make Working	First Interview (all women)	First Interview (if answer at second also)	Second Interview
More Sensible?	735 (44.4)	291 (36.0)	252 (31.2)
Less Sensible?	479 (28.9)	267 (33.0)	338 (41.8)
Neither?	443 (26.7)	251 (31.0)	219 (27.1)
Total	1657 (100.0)	809 (100.0)	809 (100.0)

The first point to make about this table is the surprisingly high number of women who believe that their husbands' unemployment makes it neither more nor less sensible for them to work. The proportion giving this response is fairly constant at both interviews, and the small differences which do exist are not statistically significant. To the extent that the unemployment of the household head will typically entail significant changes in household income, these replies indicate that economic considerations are not the only ones regarded as important. Of course, if unemployment does not, in fact, entail an important loss of household income, as would be the case if the replacement ratio were high for the husbands of the women surveyed, then this interpretation is not valid.

The second obvious point to make about the table is that the attitudes of these women appear to change over time. At the first interview (first column), the most common answer given is that the unemployment of a woman's husband makes it more sensible for her to work, whereas at the second interview, the most usual response is that it makes it less sensible. The differences between the numbers answering 'more sensible' and 'less sensible' at the two interviews are statistically significant at the 99% level of confidence. There are several possible explanations for this change over time. One is that more households are affected by means testing at the second interview, because of the exhaustion of UB, and that the changing answers directly reflect the increased disincentive associated with means testing. A second possibility is that, as the

spell of unemployment goes on, more is learned about how the benefit system works, and the effect of means testing is better understood

When those who do not answer at the second interview are excluded from the first interview answers, the difference between the two interviews in the number believing working to be more sensible loses its significance. But although the difference in the number replying that working is now less sensible is not as striking when women whose husbands are employed at the second interview are excluded, there remains a difference between the two interviews that is statistically significant at the 95%, although not at the 99% level.

A final issue which arises in discussing Table 2.10 is the source of the difference between the first and second columns. The table records that women whose husbands turn out to have a worse labour market performance, being unemployed at the second interview, are more likely at the first interview to think working less sensible (33%, as opposed to 28.9% for the whole sample) and less likely to think working more sensible (36% against 44.4%). This point is made more explicit by Table 2.11, which classifies responses according to whether they come from women whose husbands exit from the sampled unemployment spell before the second interview or not.

Table 2.11. Wives' views on paid work at the first interview, by whether the husband's unemployment spell lasted over fifteen months (Exit = 0) or not (Exit = 1). Percentage of each group in brackets.

View on Work	Exit = 0	Exit = 1
More Sensible	244 (37.3)	491 (48.8)
Less Sensible	213 (32.6)	266 (26.4)
Neither	196 (30.0)	247 (24.5)
Total	655 (100.0)	1004 (100.0)

The figures show that women whose husbands have longer spells of unemployment view working as less sensible because of their husbands' unemployment than women whose husbands have shorter unemployment spells, even before the duration of the unemployment spell is revealed. One reason for this may be that longer term unemployed men are less attached to the labour market, and that their wives are similarly less attached, either due to lower wages or low taste for work.

Table 2.12 shows the breakdown of reasons for the beliefs expressed at both interviews about the sense of working. It is reassuring to note that the answers given here are compatible with those given to the more general question, shown in Table 2.10. At the first interview, 35% of women refer to the positive financial benefit of working in motivating their replies, while at the second interview, just 20% do. But at the second interview, 37% mention that working is not worthwhile financially, an increase from 27% saying this at the first. Although it is tempting to interpret these latter responses as referring directly to the disincentive effect of means testing, these women may also be considering the fixed costs of working, as well as the low wages that they may command on the labour market. Nonetheless, the sizeable increase over time in the proportion with the perception that working is not worthwhile financially indicates that means-testing disincentives may be relevant to these answers. Again, the higher proportion giving this reason at the second interview could be because of the increase in the number receiving SB rather than UB, or because of an increasing realization of the effect of means-testing rules on the family's income.

Table 2.12. Reasons for views on paid work at first and second interviews. Percentages for each interview in brackets.

Reason for View on Paid Work	First Interview (all women)	First Interview (if answer at second also)	Second Interview
Positive Financial Benefit	568 (34.9)	213 (27.1)	153 (19.5)
Social Benefit	122 (7.5)	59 (7.5)	56 (7.1)
Not Worthwhile Financially	435 (26.8)	232 (29.5)	293 (37.3)
Domestic Commitments	228 (14.0)	131 (16.7)	110 (14.0)
Other Commitments	130 (8.0)	83 (10.6)	49 (6.2)
Other	143 (8.8)	68 (8.7)	125 (15.9)
Total	1626 (100.0)	786 (100.0)	786 (100.0)

As before, the gap between the proportion believing paid work to be more sensible than if the husband were employed - here largely represented by 'positive financial benefit' - at the first and second interviews is reduced when those whose husbands are employed at the second interview, and therefore do not answer the question, are excluded from the responses at the first interview (second column); nonetheless, the difference between the second and third columns remains significant at the 95% level.

The impact of excluding these women on the gap between those answering that work is 'not worthwhile financially' is smaller and again, there remains a large and statistically significant difference between the two interviews in the proportion answering in this way.

Thus, after excluding women whose husbands are employed by the second interview, there remain significant differences between the proportions of 'not worthwhile financially' responses at the first and second interviews and between the proportions of 'positive financial benefit' responses at the two dates. This indicates that a 'similar tastes for work' explanation may not be sufficient to account for all of the difference in the wives' views about the impact of a husband's unemployment at the two interviews. This point is reinforced by the fact that the proportion who cite 'social benefits' to working is constant across groups. The data in this table indicate that the most likely explanation for differing attitudes to work is that spouses are likely to have similar levels of human capital; hence low-skilled men are likely to have low-skilled wives, who command a low wage on the labour market and thus perceive little financial benefit in working when their husbands become unemployed.

A tabulation of attitudes according to the labour market status of the wife, shown in Table 2.13 is also interesting. The table shows that the more hours a woman works, the more likely she is to view work as being more sensible when her husband is unemployed, and the less likely to view working as less sensible. This may be because hours worked are a reflection of a woman's labour market attachment.

Table 2.13. Wives' views on paid work at the first interview, classified by their job status at that date. Percentages of each group in brackets.

Views on Work	Job Status at $t = 3$				Total
	Full-Time	Part-Time, > 10 hours	Part-Time, < 10 hours	None	
More Sense	202 (83.5)	165 (72.4)	44 (53.0)	324 (29.3)	735 (44)
Less Sense	13 (5.4)	43 (17.8)	23 (27.7)	400 (36.2)	479 (29)
Neither	26 (10.7)	20 (8.3)	16 (19.3)	381 (34.5)	443 (27)
Total	242 (100.0)	228 (100.0)	83 (100.0)	1105 (100)	1658

Some of the results for non-working women are especially interesting. In particular, the number of non-working women who believe their husbands' unemployment

to make their working more sensible is surprising, albeit lower than in the case of working women. This may indicate labour market constraints, if these women wish to work, but do not; alternatively, it may mean that although these women can appreciate that working makes more sense when their husbands are unemployed, it still does not make *enough* sense to justify entry into the labour market. This raises the issue of what 'more sense' means to the women surveyed; although it might be hoped that it means that a husband's unemployment makes the probability of working higher, even if not to the extent that a transition would be optimal, it may in fact be understood by the women surveyed to apply only if a transition into work has become optimal.

A final interesting point is the high number of non-working women who believe that their husbands' unemployment makes no difference to whether they work or not - 34.5% think working to be neither more nor less sensible as a result of their husbands' unemployment, a figure that is significantly higher than for any other group. This may be a reflection of the impression formed in Section 2.3 that non-working women tend to be stayers to a greater extent than working women.

2.6 Conclusions

In this chapter, the Living Standards During Unemployment Survey, from which the data used in this thesis come, has been introduced, and attention called to the main features of the data.

The main advantage of this survey over others which have been used to study the labour supply of the wives of unemployed men is the fact that the data were collected over a sixteen month period, from one month before the husband's unemployment began to a time when he may have returned to work, or his entitlement to UB may have been exhausted. However, several disadvantages of the data were also enumerated, particularly the absence of data on education, work experience and race, and the fact that hours of work were collected in grouped format.

The preliminary analysis of the data indicated that the women surveyed make transitions to a greater extent than British married women do in general, suggesting that they are responding to their husbands' unemployment. The patterns found in a preliminary analysis of the transitions matrices of the women include:

- Lower employment rates amongst the wives of men whose spells last longer and those whose husbands do not receive UB, even before the sampled unemployment spell begins.
- A greater movement away from work than towards work, particularly in the early stages of the unemployment spell.
- A predominance of transitions between working and not working, rather than among working states.
- A markedly higher tendency among initial non-workers to be stayers than among those working before their husbands' spells began.
- A higher proportion of added workers amongst women whose husbands' unemployment spells were shorter.

Weekly data on the labour force status of the wives were also examined for evidence of an effect of a husband's UB exhaustion on the wives' labour supply, but none was found. The conclusion was drawn that the data on week-by-week labour supply were inadequate for further more detailed analysis.

Finally, data on the attitudes to work of the wives were examined. These provided some support for the hypothesis that increased means testing after UB entitlements have been exhausted creates a disincentive to work. Again, differences in women according to the eventual duration of their husbands' unemployment spells were found, wives of men with longer spells being more likely to perceive no benefit to their working, probably because of low wages earned in the labour market.

3. An Analysis of Household Income when Benefits are Means-Tested

3.1 Introduction

From the descriptions given in Section 1.3 of the rules of the British benefit system, it is clear that the operation of the system must have important implications for the income of the household, both because of the level of income that is paid to the household and because of the fact that that income is means-tested. In this chapter, a variable representing total household income under the rules of the benefit system as it operated in 1983-84 is constructed for each of the households in the *LSUS*. Because the level of household income depends on the labour supply of the wife, total household income is calculated for each of the four alternative labour market states in which she may be observed, and for each of the three principal dates. Of course, household income depends also on the husband's labour supply, but unemployed household heads are assumed to be genuinely constrained in their labour market behaviour,¹ so that the variable is constructed by taking as given the observed job status of the husband, rather than for each possible combination of labour market states of husband and wife.

The first issue that arises in simulating these total household income variables is that, as usual when dealing with the labour supply of married women, no wage rates are reported by women who do not work at any of the three principal dates,² so that in order to evaluate the household income that would pertain for these women if they did work, their market wage rate must be estimated. The estimation of the gross hourly wage is reported in Section 3.2.1, the calculation of the net wage from the gross in

¹ This assumption is discussed further in Section 3.7.

² If a woman worked between the two interviews, but not at any of the principal dates, so that her having worked is recorded only in the weekly data collected at the second interview, then her wage rate is not reported.

Section 3.2.2, and an assessment of the reliability of the results is given in Section 3.2.3.

The wife's wage income is just one component of the calculation of the total income that each household would receive given her labour market state. The benefit income that the household would receive for each possible state must also be simulated. There are three elements to be included - UB, SB and HB. These calculations are outlined in Section 3.3.

Having calculated total household income in each state, attention is turned to the analysis of the variables for the remainder of the chapter. In Section 3.4, the total household income variables are analysed for evidence of the effect of unemployment and means testing on household income. Also, the income which would apply in the absence of means testing is compared with income under the system as it stood in 1983-84. In Section 3.5, the rate of withdrawal of benefits - the 'tax rate' implied by the means testing of benefits - is calculated and discussed. In Section 3.6, the data on women's attitudes to working when their husbands are unemployed, introduced in Section 2.5, are examined for evidence that these attitudes reflect the negative effects of means testing on the incentive to work. Finally, in Section 3.7, the assumptions which are implicit in the construction and use of a household income variable are identified and discussed. Section 3.8 concludes.

3.2 The Estimation of a Wage for Non-Working Women

3.2.1 Wage Estimation

Many of the disadvantages of using the *LSUS* data which were enumerated in Section 2.2.3 are relevant to the estimation of a wage equation to a greater extent than to any other element of the analysis in this thesis. The steps taken to deal with these problems are outlined in this section.

The first important problem faced in estimating the wage is that hours of work data are collected in three hours ranges - full-time work, part-time work of more than ten hours per week, and part-time work of less than ten hours per week. This means that, even for those women who do work, their exact hourly wage, either gross or net,

is not known, since the wage information collected is for the amount earned in the last pay period, which ranges between a week and a year. The frequency with which each individual is paid is known, so that the calculation of the weekly wage of each woman is straightforward, but the adjustment to the hourly wage is not.

The approach taken in dealing with the absence of information on hours worked is to assume that full-timers work 37 hours per week, those working high part-time hours work 20 hours per week and low-hours part-time workers work 7 hours per week. These figures for the hours typically worked in each hours range are the mean hours worked in the relevant hours ranges by a sample of married women from the 1981 Family Expenditure Survey (FES). Weekly pay is divided by the applicable number of hours for each working woman. In a small number of cases (fewer than 20 for each principal date), women report the same wage at two consecutive dates, but different hours of work ranges; in these cases, it is assumed that a woman works 10 hours at both dates if she reports working low part-time and high part-time hours at two consecutive dates, and 30 if she reports high part-time hours and full-time work at two consecutive dates.

A second significant problem with the *LSUS* data for the estimation of wages for non-workers is the absence of several key variables which are explanatory of wages. Most importantly, the education levels of neither spouse are available. The education level of the husband could have been used as a proxy for that of the wife had it been included, given the correlation between spouses' education levels. Secondly, as is often the case, women who are not working are not asked to indicate with what industry or occupation they are associated. Thirdly, labour market experience variables are not included. Finally, there is a problem of missing wage data for husbands; 143 men do not report a wage at any date. This complicates the use of the husband's wage as an explanatory variable in the wife's wage estimation.

Because of the problems with suitable explanatory variables, the approach to estimation is pragmatic, both in the choice of the estimation method and the model specification. The criterion used in deciding on the final version is the maximization of the explanatory power of the model, as given by the adjusted R^2 .

A first step towards this goal is to maximize the number of individuals over whom estimation is performed. Thus, for women who report a wage at one or two of the three principal dates, but not at one of the others, the gross wage rate for the missing date is calculated as the reported one appropriately adjusted for wage inflation. The rate of increase in the within-sample median wage between dates is used in preference to the national rate of wage inflation on the basis that the wives of the unemployed are unlikely to be typical of all women. Between the key date and the first interview, median wages for workers in the *LSUS* sample increased by 2.4%, and between the first and second interviews, the increase was 3.3%, giving an increase over the whole sample period of 5.7%, and these are the figures used in imputing the wage rate from dates at which it is provided to dates at which it is not. A related point is that at any one date, there are several women who report a net wage but not a gross wage. However, all of these women do report a gross wage at another date, so the gross wage rate, where reported, is used to calculate the gross wage rate for the date at which it is missing, in preference to making some guess as to the difference between the gross and net wages.

The estimation method used is Ordinary Least Squares (*OLS*). This method has been criticized for yielding biased estimates in wage estimations using workers only because of the problem of sample selection. This results from the fact that, although in the population, unobservable variables that determine the wage rate, such as motivation and ability, are normally distributed:

$$W_i = f(HC_i, \varepsilon_{wi}) \quad \varepsilon_{wi} \sim (0, \sigma_w)$$

where W_i is the individual i 's wage, ε_{wi} represents the unmeasured factors and HC_i , the human capital variables, it is likely that those with higher motivation and ability also have higher wages so that,

$$E[\varepsilon_{wi} | i \text{ works}] \neq 0$$

Thus, to the extent that the ε_{wi} are correlated with the W_i , the regression of the latter on human capital variables, but not on the non-zero conditional mean of ε_{wi} , yields biased estimates of the population wage parameters.

Heckman (1979) proposed a method of addressing the problem of selection bias which is based on the fact that the mean of ε_w , conditional on working can be shown to be

$$K_i = \sigma_w \lambda_i$$

where λ_i is the inverse of Mill's ratio, defined as

$$\lambda_i = f_i / 1 - F_i.$$

In the two step Heckman procedure, estimates of λ_i , and hence of K_i , are obtained for all individuals from a logit or probit estimation of participation and then K_i is included in an *OLS* regression of wages.

The paucity of the information available for wage estimation has implications for the implementation of such a selection bias-corrected estimation, however. This is because the procedure requires at least one variable in the participation equation that is not in the wage equation in order to identify the equation.³ Often, a variable such as the age of the youngest child might reasonably be regarded as having little influence on the wage that a woman can command in the market, while being an important determinant of the participation decision, and therefore suitable for use as an identifying variable. However, in the absence of other data on past labour market experience, and years out of the labour force in particular, the number and ages of children are the only variables available as a proxy and must therefore be used in the wage equation.

Several alternative identifying variables were experimented with, such as the local unemployment rate, whether the husband had ever held a full time job, and whether the husband had been unemployed in the five years prior to his sampled spell. However, in each case, the correlation between the participation and wage equations, which indicates the extent of the selection bias, was insignificant at all usual levels of confidence.

³ Formally speaking, this is not true, since it is theoretically possible to identify the wage equation from the difference in functional form between the two equations. In practice this is difficult.

A final point is that the wage regression is carried out only for one date, that of the first interview. The predicted wages for non-workers are then extrapolated to the other two dates using the adjustment for wage inflation described above. This procedure is used in preference to running separate regressions for all three dates in order to avoid the complications that would arise if the predicted wage of a woman at $t = 15$ were lower than that at $t = 3$, without any change in her circumstances having occurred, simply because of a slight difference in a parameter estimate between dates. The first interview was chosen because the R^2 associated with the 'best' specification at that date proved higher than the R^2 values of the best specifications at other dates.

The estimation results are shown in Table 3.1. Estimations are carried out and wages predicted separately for those whose husbands report a wage and for those whose husbands do not. The alternative to this is to estimate over all women, including both the husband's wage, replaced by zero if not reported, and a dummy for the non-reporting of his wage. But when this procedure is used, an F -test does not reject the exclusion of the husband's wage. Yet the correlation between actual and predicted wages for workers is reduced with respect to the model reported below both when the husband's wage is included, and when it is not and estimation is carried out over all individuals.

The variables for a woman's age and the number of children she has had combine to represent her potential labour market experience, although clearly age also captures a cohort effect. Age is included as a linear spline, and the results shown in the table indicate a positive but insignificant effect of age up to 40 years old on the wage rate, and a significant negative effect of age between 40 and 50 years old and over 60 years. The more children a woman has, the lower her wage, as indicated by the negative coefficients on the children dummies that increase in the number of children.

The husband's wage, where reported, has a strong positive relationship with the wife's wage, as can be seen from Model 1 of Table 3.1; the coefficient indicates an elasticity of the wife's wage with respect to the husband's wage of about 7%. The husband's occupation and industry are proxies for social class, and hence education. Because of the combination of categories that are omitted, it is difficult to comment on the interpretation of the results, but it is not clear that education is, in fact, being proxied, given that the effect of being married to an employer or manager, which might

Table 3.1. Results of OLS Wage Estimation. Dependent variable is the log gross hourly wage.

Variable	Husbands Reporting Wages (1)		Husbands Not Reporting Wages (2)	
	Coefficient	t-Statistic	Coefficient	t-Statistic
Log of Husband's Wage	0.0694	1.65	—	—
Age Spline: under 40	0.0060	1.45	0.0089	1.05
40 to 50 years	-0.0190	-2.26	-0.0317	-1.92
50 to 60 years	-0.0078	0.46	0.0441	1.60
over 60 years	-0.1889	-2.24	—	—
Dummy: One Child	-0.1409	-2.57	—	—
Dummy: Two or Three Children	-0.2226	-4.09	-0.4357	-4.71
Dummy: Four or More Children	-0.2437	-1.78	-0.5025	-2.87
Husband's Occupation Dummies:				
Employer/Manager in Large Establishment	-0.1453	-1.69	-0.2243	-1.26
Employer/Manager in Small Establishment	-0.1372	-1.58	0.4867	2.65
Self-Employed Professional	0.6658	1.32	0.9557	2.04
Personal Services Worker	-0.3561	-1.81	—	—
Manual Foreman	-0.2416	-2.83	—	—
Skilled Manual Worker	-0.1631	-2.50	-0.1106	-1.32
Semi-Skilled Manual Worker	-0.1711	-2.26	—	—
Unskilled Manual Worker	-0.1873	-1.58	—	—
Self-Employed Non-Professional	-0.3996	-3.47	—	—
Farmer Employing Others	-0.9486	-1.88	—	—
Agricultural Worker	-0.4301	-2.41	—	—
Member Armed Forces	-0.2852	-1.46	—	—
Husband's Industry Dummies: Other Services	0.1589	2.76	—	—
Other Manufacturing	-0.1354	-1.96	—	—
Metal, Engineering and Vehicles	—	—	-0.1106	-1.32
Dummy: London Resident	0.1697	2.55	0.4805	3.47
Dummy: Resident Rest of South-East England	0.1813	3.13	0.3168	2.37
Dummy: Resident South-West England	-0.2470	-2.73	-0.3851	-1.83
Dummy: Resident Wales	—	—	0.1752	1.44
Constant	4.9658	19.47	5.1511	20.02
	No. Observations: 618		No. Observations: 143	
	R ² : 0.153		R ² : 0.314	

Notes: Omitted occupational groups in Model 1 are: Employed Professional Worker; Intermediate Non-Manual Worker; Junior Non-Manual Worker; Not Stated. Omitted child variable is 'none'. There were no women aged over 60 among those whose husbands did not report a wage; hence its omission in Model 2.

be expected to reflect a higher level of education, is negative for women whose husband's report their wage rates. Combining occupations according to the education level likely to be required was experimented with - for example grouping all occupational categories requiring a degree - but this did not improve the model's adjusted R^2 .

The dummies for the region the household is in allow for local labour market conditions. Living in London or the rest of the south-east of England, and, for those whose husbands do not report a wage, in Wales, means being paid more, while living in the south-west of England is associated with a lower wage. The fact that the coefficients are larger in Model 2, where the husband's wage is not included, suggests that, in addition to the regional effects, this variable captures the correlation between husbands' and wives' earnings, by way of the regional variation in male wages.

Having predicted the hourly wage at $t = 3$ for the sample according to the parameters shown in Table 3.1, then, for each date, the constructed wage variable is defined as:

- The actual wage rate, if reported.
- The actual wage rate for another date, adjusted for wage inflation if the wife does not report a wage for the date in question, but does report one for another date.
- The wage predicted on the basis of Model 1 in Table 3.1, including the husband's wage as a regressor, if the wife reports no wage at any date, but her husband does report a wage at some date; the predicted wage rate is adjusted for wage inflation for the key date and second interview.
- The wage predicted on the basis of Model 2, if the wage rate is not available for either husband or wife, again adjusted for wage inflation for $t = -1$ and $t = 15$.

The summary statistics for the actual gross wage rate and the variable generated as described above are shown in Table 3.2. The table shows, as would be expected, that the medians of the constructed hourly wage variables, which cover both workers and non-workers, are lower at each date than those of the actual hourly wage variables, which are, by definition, for workers only.

The figures reported in the table may also be compared with the national distribution in the relevant years. In April 1983, at around $t = -1$, the median gross hourly

wage of all women was higher than that of either actual or constructed wages for the *LSUS* sample, at £2.62; the same point holds for April 1984, when the national median gross hourly wage was £2.80 (CSO, 1987). Even if non-manual workers are excluded, both actual and constructed *LSUS* wage distributions have lower medians than the distribution of female manual workers' wages; nationally, the median wage for manual workers was £2.16 per hour in 1983 and £2.27 per hour in 1984. This comparison highlights one of the differences between the average British woman and those whose husbands are unemployed.

Table 3.2. Summary statistics for actual gross hourly wage, adjusted for inflation where necessary, and the constructed hourly wage variables, in pounds.

Variable	No. Obs.	Median	Minimum	Maximum
Actual Gross Hourly Wage at $t = -1$	761	1.99	0.30	20.00
Actual Gross Hourly Wage at $t = 3$	761	2.01	0.30	20.00
Actual Gross Hourly Wage at $t = 15$	761	2.12	0.30	17.14
Constructed Hourly Wage at $t = -1$	1727	1.83	0.23	20.00
Constructed Hourly Wage at $t = 3$	1727	1.86	0.24	20.00
Constructed Hourly Wage at $t = 15$	1727	1.95	0.25	17.14

3.2.2 The Calculation of Net Wages

Gross wages having been estimated for everyone in the sample, the next step is to calculate net wages. Although data on net wages are collected in the *LSU* survey, the level of taxation does not increase linearly with gross income, so that the proportion of gross income paid in taxation is not the same if working 7 hours as if working 37 hours. Moreover, because of the lower and upper earnings limits which apply in calculating the amount of National Insurance (NI) contributions payable, the same point applies to these contributions. Because of the non-linearity generated in the budget constraint by the tax and NI systems, the rules of the systems are used to simulate the net income that would be received in each of the three hours regimes, using the gross hourly wage figure obtained as described above as the basis of the calculations. All details of the tax system are provided in Appendix A.

The net wage figure is arrived at as follows:

- The gross hourly wage is converted to a weekly wage for each of the three hours regimes, by multiplying by the number of hours assumed to hold in that range; this yields nine variables for each woman - one for each hours regime and for each date.
- The annual wage in each hours regime is calculated. For $t = -1$ and $t = 15$, this involves multiplying by 52, but since the tax year relevant to $t = 3$ begins in April, at around the key date, the wage rate at $t = -1$ is assumed to hold until half way between that date and the first interview, so that the annual wage for $t = 3$ is a weighted average of the weekly wage at $t = -1$ and that at $t = 3$.
- Tax free allowances are allocated next. In the relevant years, 1983 and 1984, a couple could choose to be assessed either individually or together. Being assessed together involved an assumption that the wife's income was the husband's; the husband was given a married man's tax free allowance, and wife's earned income relief was added to this. Being assessed separately, on the other hand, meant that both partners were allocated the allowance of a single person. At the time most couples were assessed together, as this was the default. However, treating couples in this way would require that the unemployment payments the husband would receive at different hours of work of the wife be calculated, since these are also taxable. Since these are based on the net income of the wife, the calculation becomes circular. For this reason, women are treated as though their taxable income is assessed independently of their husbands'. Taxable income for each of the three possible hours of work is generated by subtracting the relevant tax free allowance, given in Section A1, from each of the three annual gross income figures at the three dates.
- Taxes payable in each hours regime are calculated according to the tax rates given in Section A1.
- The amount of NI contributions payable is calculated, according to the rules given in Section A2.
- Finally, total deductions in each hours regime and at each date are calculated by adding together the tax and NI payable. The total deductions figure is subtracted from the relevant annual gross income figure to give net income at each of three dates and three hours regimes, and from this a weekly figure is obtained.

Table 3.3. Summary statistics for the constructed net wage variables, in pounds, for each principal date, t , and each hours range.

Net Wage Statistic	$t = -1$			$t = 3$			$t = 15$		
	FT	PT > 10	PT < 10	FT	PT > 10	PT < 10	FT	PT > 10	PT < 10
Mean	55.91	34.86	14.01	56.83	35.38	14.24	60.09	37.35	14.91
Mean Hourly	1.51	1.74	2.00	1.54	1.77	2.03	1.62	1.87	2.13
Median	51.54	32.60	12.80	52.69	33.25	13.06	55.46	35.30	13.65
Minimum	8.65	4.67	1.64	8.85	4.79	1.68	9.15	4.94	1.73
Maximum	423.43	258.91	95.70	442.97	264.18	96.78	382.89	228.25	84.77
Mean Tax Rate	0.229	0.103	0.003	0.231	0.107	0.003	0.221	0.099	0.003

The distribution of the net wage variable calculated as described above is shown in Table 3.3. The row showing the mean hourly wage for each date and hours of work combination is particularly interesting, illustrating, as it does, that the hourly net wage depends to a large degree on the number of hours worked because of the non-linearity in the budget constraint introduced by the tax and NI system. The last row, which shows the average rate of deductions of tax and NI from gross weekly wages echoes this point. The table confirms the advisability of having calculated the net wage rates for different hours from the gross wage variables, rather than using a rule of thumb such as 'less one third'.

3.2.3 An Assessment of the Accuracy of the Wage Variable

There are two main stages in the construction of the net wage variable whose distribution is summarized in Table 3.3. The first is the construction of a gross wage variable and the second is the calculation from that gross wage of the net wage received. In this section, an attempt will be made to evaluate the reliability of the results obtained at the two stages.

Clearly, the construction of the gross wage is the more difficult part of the procedure. The most obvious way of assessing the accuracy of the wage estimation on the basis of which wages for non-workers are predicted is to inspect the R^2 of the wage estimation equation; at 0.153 for those women whose husbands report a wage, this is clearly very low. Because wages, where missing, are predicted on the basis of two separate wage estimations, this measure is not comprehensive, however. It is therefore

useful to report that the correlation between the actual wages reported by women who did work during the survey period, and the wages that were predicted for those women on the basis of either Model 1 or Model 2 of the wage estimation procedure is 0.36. Again, this is low.

Table 3.4. Correlations between reported net wages and constructed net wages for women in each hours range at each principal date.

Time	Hours of Work	Correlation Between Actual and Estimated Wages	Number of Observations
$t = -1$	Full-Time	.987	71
	Part-Time > 10	.973	235
	Part-Time < 10	.960	285
$t = 3$	Full-Time	.978	82
	Part-Time > 10	.962	222
	Part-Time < 10	.952	241
$t = 15$	Full-Time	.989	85
	Part-Time > 10	.949	243
	Part-Time < 10	.961	251

Table 3.4 is useful for the assessment of the accuracy of the procedure used to derive the net wage rates from the gross wage rates. It appears from the table, which shows a very high correlation between the constructed net wages and the actual reported net wages, that confidence in the simulation of the tax and NI system is justified. Thus, only the estimation of the gross wage rate for non-working women should give cause for any concern.

3.3 The Construction of a Household Income Variable

In this section, the net wage variables for each date and hours regime of the wife are used to construct further components of the total income of the household. The most involved task in building these variables is the simulation of the benefits that a household is entitled to for each of the four labour supply states that the wife can be observed in, and given the labour market state and wage income, if any, of the husband.

As outlined in Section 1.3, the British benefit system is made up of three elements: UB, SB and HB. Each of these three elements involves some degree of means testing, so that the amount received depends on the wage income of the recipient's wife. Moreover, UB is taken into account when assessing entitlement to SB, and both UB and SB are taken into account in appraising HB entitlements. Hence, UB receipts are simulated first, then SB entitlements, and finally HB receivable, using the rules that applied in 1983-84.

3.3.1 Simulating Unemployment Benefit Entitlement

The amount of UB entitlement depends on three things. First, it depends on whether the claimant qualifies at the full rate, the three-quarter rate, the half rate, or not at all. This in turn depends on his previous contribution record and the circumstances of his leaving his last employment. Second, the amount of UB depends to a small extent on the number of children the claimant has; the allowance for children was being phased out in the years in question. Third, the amount depends on whether the claimant's wife is earning more than the amount of the dependant's allowance; if she is not, then the husband receives an allowance for her, while if she is, he does not. The steps required to calculate the UB which the husband would receive if his wife worked in each hours range are outlined below:

- The husband's answers to questions on the receipt of UB are used to indicate entitlement to some payment, so if he says that he is in receipt of UB, then this is usually accepted as being the case. Exceptions to this arise at the second interview, however, since some men claim to be receiving UB, even though they have not exited their sampled unemployment spells; since it is not possible to receive UB continuously for more than one year, these men are re-coded as not being in receipt of UB at $t = 15$.
- If the head of household knows how his unemployment payment is divided between UB and SB, an attempt can be made to calculate the rate of UB to which he is entitled. By using information on the number of children in the household and on the wife's actual wages, if any, the amount which the husband would receive at each of the three rates of payment (full, three-quarter and half), given the observed labour market status of his wife, is calculated using the information in Section A3.

Then, which of these three amounts is closest to the amount of UB the husband reports receiving is identified. The corresponding rate of payment is then assumed also to apply at $t = -1$ and $t = 15$, if relevant. For men who cannot separate their UB and SB payments, the assumption is made that they are on the full rate.

- The amount the husband would receive if his wife did not work, which is the maximum amount receivable, is calculated by adding allowances for a dependant wife and children to the basic amount of UB entitlement; the amounts are given in Section A3. The basic amount and the amount receivable for the wife depend on the rate of payment established as described in the previous point.
- The amounts of UB that the husband would receive if the wife worked 7, 20 and 37 hours are then calculated by subtracting the dependant's allowance, at the relevant rate (full, three-quarters or half) from the maximum amount receivable, calculated already, if the wife's wage income at that number of hours exceeds the amount of the allowance.

3.3.2 Simulating Supplementary Benefit Entitlement

The amount of SB entitlement is calculated as the difference between needs, which depend on the number and ages of dependants, and resources, which include wage income and UB. SB is not payable to a man if he is employed full-time. Any mortgage interest which the household incurs is also receivable as SB. The steps followed in estimating the amount of SB receivable are described below:

- Needs are calculated on the basis of family composition, according to the rules described in Section A4.
- To these basic needs is added the amount of mortgage interest if the householder is a mortgage holder. This requires an estimation by regression, since 180 of 553 householders holding mortgages do not know how much of their mortgage payments comprise interest payments. For those who do know this information, the log of the fraction of their annual mortgage payments which is interest is regressed on the number of years of the mortgage left to pay and on a dummy equal to one if the mortgage is held with a building society, for the dates of the first and second interviews. Using the resulting coefficients, the fraction of the mortgage which is

interest is predicted for those households who do not know their mortgage interest alone, and also for those households who report mortgage interest to be higher than their total mortgage payment, since this is impossible; there are 59 such households at the first interview and 31 at the second. This fraction is then multiplied by the total mortgage payment reported to obtain figures for mortgage interest for all mortgage holders.

- Allowances for the maintenance of the family home and for extra heating, outlined in Section A5, are added to needs. The amount of water rates payable is also added.
- The resources of the household are calculated for each date and for all possible hours of work of the wife - 0, 7, 20 and 37. Resources include the part of the husband's net weekly wage, if any, above the disregard of £4, and similarly, the wife's net wage, if any, over £4.
- Also added to household resources are other amounts of benefit income, including child benefit, sickness benefit and any reported receipt of Family Income Supplement (FIS). There are two difficulties with treating FIS as endogenous to the wife's labour supply, which it in fact is. One is that the take-up rate of this benefit, designed for families whose head is in work, is low; Dorsett and Heady (1991) estimate it to be about 59% in 1984-87. More seriously, however, the calculation of entitlement is very difficult, as FIS is paid at a constant rate for a year even if household income changes, so in many cases, the income reported at a particular date may not qualify the household for FIS, but at some previous date the household may have qualified and therefore be in receipt of the benefit. Hence, the decision was reluctantly taken to treat FIS payments as exogenous to the wife's labour supply.
- For the zero hours option of the wife, any unemployment payments, whether UB or SB, that she reports receiving are also added. The entitlement to unemployment payments that a working woman would have if she became unemployed is not calculated, since insufficient information is available both on whether women are unemployed or not participating if not working, and on past labour market history.

- For each hours possibility, the amount of UB received by the husband given the relevant number of hours of work of his wife is added.
- Finally, weekly non-labour income is added; this is calculated to include rental income, and interest on savings at the rate of 6.25% at the key date, 5.75% at the first interview and 7.25% at the second interview.⁴
- The SB entitlement at each date for each job status of the wife is then calculated as the difference between needs and resources. The entitlement at all hours of work of the wife is reduced to zero if the household's total savings are greater than £2,500 (£3,000 at the second interview), or if the husband is working full-time.

3.3.3 Simulating Housing Benefit Entitlement

Housing benefit is divided into two types. The first, 'certificated' benefit, is automatically receivable by those in receipt of SB, and pays 100% of eligible rent and rates.⁵ The second, 'standard' housing benefit is based on a comparison of needs and resources. At the date of the first interview of the *LSU* survey, the HB system was in the process of being changed, and a transitional payment of HB was available for those who would lose under the new system. However, since insufficient information regarding previous HB receipts was available in the survey to calculate these transitional payments, the new system was assumed to apply. Thus, the amount of HB to which a household is entitled, given the hours of work of the wife, is calculated as follows:

- The needs of the household for 'standard' housing benefit entitlement are determined according to the information in Table A5.
- The resources of the household are calculated for the different possible hours of work of the wife. Resources include the gross weekly income of both the husband and wife. The spouse who earns more is allowed an earnings disregard of £18, while the one earning less has a disregard of £5.

⁴ These figures were derived from data in Table 17.9 of the Annual Abstract (CSO, 1987).

⁵ Water rates are not included.

- Added to these resources are weekly non-labour income, calculated to include interest on savings and other benefit income, as described above for the case of SB, and the husband's UB entitlement, if any.
- The starting figure for HB is 60% of rent and rates paid. From this a deduction is made for each non-dependant in the household, as outlined in Table A6 of Appendix A.
- To this adjusted starting figure, for both rent and rates, is added a percentage - the 'taper' - of the difference between needs and resources if the former are higher than the latter, and a reduction by a typically higher percentage if resources are higher than needs. The tapers are detailed in Section A5.
- The figures for rent and rates allowances at different hours of work of the wife, and hence different resources of the household, are then added together, with the adjustment made that no less than 30p can be paid per week, so that if the entitlement is positive but less than 30p, the amount is adjusted upwards.
- Finally, if the husband is entitled to SB at any of the possible hours of work of the wife, then for the HB variable corresponding to those hours, the standard HB entitlement is replaced with the certificated entitlement, which is the total amount of the rent and rates, less the deductions for non-dependants outlined above.

3.3.4 An Assessment of the Accuracy of the Benefit Variables

The accuracy of the benefit variables constructed as described in the foregoing sections depends on the accuracy both of the wage variables, which has been discussed in Section 3.2.3, and of the procedure simulating the benefit system. The accuracy of the simulation procedure can be assessed by comparing the simulated values of benefit entitlements with the actual amount the head of household reported to be receiving in cases where the wives were actually working in the relevant hours range. Since these amounts are based on the observed wage income of the wife, such an examination abstracts from the problems of inaccuracies in the wage variables and focuses on the generation of the benefit variables only.

Clearly, the social welfare system in Britain at the time of the survey was very complex, so that comparisons such as this cannot be taken as an absolute indicator of

the accuracy of the variables, some reported amounts also being likely to be incorrect. One indication of the complexity of the system is given by the number of men who cannot distinguish between their UB and SB entitlements, of which there are 483 at the first interview. Another is the number of men who claim to be in receipt of UB at the second interview, even though their answers to other questions indicate that this is impossible. Notwithstanding these difficulties, Table 3.5 shows some indicators of the accuracy of the UB and SB predicted amounts. The data collected for HB receipts was too piecemeal to perform the same exercise for this benefit type.

Table 3.5. Percentages of estimated benefit receipts within 10% of reported benefit receipt for those whose wives actually worked the relevant number of hours.

Time	Wife's Hours of Work	Percentage of Simulated Benefit Amounts within 10% of Reported Amount					
		UB		SB		UB+SB*	
		%	No. Obs.	%	No. Obs.	%	No. Obs.
<i>t</i> = -1	None	52	31	53	139	58	36
	Part-Time < 10	100	1	33	3	—	—
	Part-Time > 10	87	15	20	10	33	3
	Full-Time	76	17	0	6	—	—
<i>t</i> = 3	None	69	367	65	423	75	421
	Part-Time < 10	78	41	24	21	80	25
	Part-Time > 10	92	147	27	55	33	30
	Full-Time	95	180	0	17	29	7
<i>t</i> = 15	None	63	38	68	579	76	62
	Part-Time < 10	50	2	52	29	40	5
	Part-Time > 10	53	15	30	13	75	4
	Full-Time	71	17	0	7	100	1

* Where the men could not distinguish between the SB and UB elements of their benefit payments.

Table 3.5 indicates that the calculations for amounts of UB received are fairly close to the actual amounts reported. The consistently lower level of accuracy of UB receipts for men whose wives do not work appears to have its source in mis-reporting to a large extent. For example, about a third of those for whom the difference between the simulated and reported UB entitlement is greater than 10% at the first interview claim to be receiving £25 per week in UB; this is the amount to which a man with no

children and receiving no dependant's allowance for his wife is entitled, whereas all these men are entitled to a dependant's allowance for their non-working wives.

For SB, however, the accuracy is not as high in general, and is particularly low for the benefit received by the husbands of full-time working women, although the small number of these women makes this issue less worrying that it might otherwise be. An important point to note regarding the amounts reported as being received as SB in the survey is that, since those who are entitled to some SB are also automatically entitled to 'certificated' HB, they do not need to apply to the local authority for the latter benefit and may therefore believe that HB is part of their SB. This may account for the lower levels of correlation between reported and simulated SB.

3.4 An Analysis of Household Income

In Section 1.3.1, the budget constraint of a hypothetical, 'typical' woman was illustrated, and the areas of the constraint where she has least incentive to work identified. In this section, the wage variables produced as outlined in Section 3.2, and the benefit variables constructed according to the procedure described in Section 3.3 are used to illustrate the actual effect of means testing on total household income for the women in the *LSU* survey.

Total household income for a given number of hours of work of a woman comprises total benefit income, including child benefit, FIS and sickness benefit as well as unemployment payments to either husband or wife, non-labour income such as interest from savings, her husband's net wage income, if any, and her net wage for the relevant hours range, simulated as necessary. Table 3.6 shows the medians of the total household income variables for various observed job and benefit entitlement positions of the husbands, at each of the three principal dates.

This table is useful in that it allows a comparison of the effects of UB and SB on household income, as well as a measure of the effect of unemployment *per se*. The entries for the date of the first interview are particularly useful for the comparison of the effects of UB and SB, since large numbers of unemployed men fall into both the 'entitled to UB' and 'not entitled to UB' categories at that date. On the other hand, the entries for the key date and the date of the second interview are more useful in con-

trasting the situation of the employed with that of the unemployed who are on SB only, since a large number of men are at work at $t = -1$ and $t = 15$, but few of those who are not at work are eligible for UB.

Table 3.6. Median total household income, in pounds, by wife's job status and husband's job status at the three principal dates.

Time	Husband's Actual Job Status	No. Obs.	Wife's Potential Job Status			
			None	P-T < 10	P-T > 10	Full-Time
$t = -1$	Working	1076	103.90	116.24	134.18	153.13
	Not Working	651	72.43	78.26	88.73	91.84
	On UB	106	73.78	78.46	85.54	96.26
	Not Working, Not on UB	519	73.79	80.03	85.60	92.17
	All	1727	91.75	101.47	117.16	133.12
$t = 3$	Working	66	77.84	87.81	95.87	112.11
	Not Working	1661	75.99	80.75	84.42	94.43
	On UB	1227	75.92	81.13	85.83	97.34
	Not Working, Not on UB	468	76.37	80.39	81.39	85.54
	All	1727	76.10	80.95	84.89	94.81
$t = 15$	Working	695	111.02	123.44	144.61	167.86
	Not Working	1032	79.53	84.45	87.56	92.32
	On UB	107	85.70	90.07	92.14	104.35
	Not Working, Not on UB	925	78.95	83.72	86.76	90.65
	All	1727	89.50	96.70	101.69	110.65

There are several feature of the statistics in the table which appear to be anomalous at first glance and which should be clarified first. One is that total household income when the husband is working is significantly lower at $t = 3$ than at $t = -1$ or $t = 15$. This is because at the first interview, no husband is employed full-time; all those working are registered as unemployed and must therefore be working part-time, whereas at the other dates, the majority of working men are in full-time employment.

A second peculiarity is that the number of households where the husbands are entitled to and therefore receiving UB, and the number where the husbands are not working but not on UB do not add up to the number of households where the husband is not working at either $t = -1$ or $t = 3$. This is because there are a number of men at both these dates who claim to be working but receiving UB. Their word on both

counts is accepted as being true, since it is possible that these men are doing some work and not reporting it to the benefit administration.

Thirdly, it is notable that at both the key date and first interview, if the wife does not work, household income when UB is received is very close to that when there is no entitlement to UB, indicating that the main difference between UB and SB is not the replacement ratio implied by the two benefits, but the means-testing structure. At the second interview, however, for the situation where the wife does not work, those eligible for UB have an income that is higher than for those in receipt of SB only. The reason for this is that benefit rates for a different year apply at the second interview, and in that year, both the basic UB and the dependant's allowance were increased by about 8%, while the rate of increase in the needs of each household member for SB was about 4%, so that in that year, a small gap opened up between the replacement rates of the two benefit types.

Finally, at $t = -1$, the median total income of households with husbands on UB is the same as, or lower than that of households with husbands who are *not* entitled to UB if the wife works part-time - £78 compared to £80 if she works low part-time hours, and £85 in both benefit situations if she works high part-time hours. This is not the expected result, given that UB entails a lower level of means testing than SB. The important point to be emphasized here is that each row of the table is calculated for a different sample of individuals, and at the key date, the wives of the 106 men entitled to UB earned, or had the potential to earn an average of £1.91 per hour in gross wages, while the wives of the 519 men not employed but not entitled to UB had a mean gross wage of £2.06. Thus, these medians reflect differences in wages as well as differences in the degree of means testing involved. At the other two principal dates, the average wage rates of the two sets of wives are almost exactly the same, so that this problem does not arise. Hence the key date is less useful for the comparison of the effects of SB and UB than the other two dates.

Having explained some unanticipated features of the tabulation, it remains to comment on the extent to which the other results confirm expectations. In Section 1.3.2, it was shown that the marginal gain in household income from working less than full-time should be very low for those affected by SB. This is borne out to a certain extent by the information in Table 3.6. At the first interview, for the wives of men not

entitled to UB, median total household income is higher by about £4 if they work 7 hours per week rather than zero hours, and by similar amounts at the other two principal dates. This is expected, as the earnings disregard is £4. The differences in median household income for further hours increments are, at $t = 3$, just £1 between working 7 and 20 hours per week, and £4 between high part-time hours and full-time work. At the other two dates, the differences are not quite so low, with an increase in median household income of about £18 when increasing hours worked from none to 37 at the key date, and of nearly £12 at the second interview. Overall, however, the increases in median household income are certainly low for those affected by SB.

But it is not clear that for women facing the SB budget constraint, the positive effect on household income of moving to full-time work from high part-time hours is much larger than for the other hours increments, as might be expected, since by increasing hours in this way, a woman is typically no longer on the part of her budget constraint that implies a 100% marginal 'tax' rate on wage income. One possible explanation for this result is that mortgage interest and other extras are added to 'needs' in calculating SB receivable, thus extending the 100% tax region into the full-time hours range, so that median income is not as much higher for 37 hours than for 20 hours as would be expected if this is not taken into account. It may also be that when working 37 hours, and leaving the segment of the household budget constraint that is determined by the SB means test, women also cause household HB entitlement to be calculated on the basis of the 'standard' rather than the more favourable 'certificated' system.

The figures for households who are entitled to UB do not conform to expected patterns very clearly either. The benefit of increasing hours from 0 to 7 is expected to be low for a household in receipt of UB, since the dependant's allowance for the wife is lost, on average, at around the 7 hours per week point.⁶ The median values confirm that the difference in household income between zero and 7 hours of work of the wife is low, although at the first interview, it is not as low as for those who are affected only by SB means testing. At $t = 3$, the difference in median income if the wives work 20 hours as opposed to 7 hours is again low, albeit not as low as in the case of those enti-

⁶ See Table 3.3.

tled only to SB. If women lose their dependants' allowance at around the 7 hours per week mark, a higher difference in median household income might be expected for the wives of UB qualifiers between 7 and 20 hours per week. The absence of this feature may be because UB qualifying households may also receive SB, if their needs are greater than their resources, and at 20 hours per week, some women are on a budget constraint which is affected by SB. Nevertheless, it is certainly true that the increase in median income due to working 37 hours is larger in the case of those entitled to UB than for those not so entitled.

These results suggest that the overlapping of the UB and SB systems, has important implications for the effect of means testing on household income. Indeed, it may be that attempting to find a distinctive effect of benefit exhaustion is mis-guided, since the distinction between the two benefit types is blurred. This may explain the absence of a difference between the wives of UB receivers and the wives of non-receivers in the timing of their labour force transitions reported in Section 2.4.

Another useful comparison is between median household income for households headed by workers and for those whose heads are not working. In terms of the effect of unemployment on potential household income, at $t = -1$, income in households where the head is working is between 43% and 66% higher than where the head is not working, depending on the labour market status of the wife, and between 40% and 80% higher at $t = 15$.

At both the key date and the second interview, median household income for women working full-time is about 50% higher than if they do not work, if their husbands are working, whereas if their husbands are not working, the difference is 27% at the key date, and just 16% at the second interview. So the husband's job status has clear implications for work incentives of the wife.

Some insight into the incentives for unemployed household heads to work part-time if they cannot find full-time work can also be gained from the table, by comparing the household incomes for households where the husband is working with those where he is not working at the first interview, since at this date all men who are working are working part-time. It can be seen from the table that the higher the hours worked by the wife, the higher the benefit to the household of his working part-time. If the wife

does not work, then the difference in median household income between households with part-time working husbands and those with non-working husbands is less than £2, while if the wife is working full-time, then the difference in median household income is £18 per week.

Table 3.7. Median total household income in the absence of means testing, in pounds, by wife's job status and husband's job status at the three principal dates.

Time	Husband's Actual Job Status	No. Obs.	Wife's Potential Job Status			
			None	P-T < 10	P-T > 10	Full-Time
$t = -1$	Working	1076	103.90	118.21	138.37	157.20
	Not Working	651	72.43	87.51	107.54	127.46
	On UB	106	73.78	90.07	107.57	128.80
	Not Working, Not on UB	519	73.79	89.35	109.76	129.14
	All	1727	91.75	104.91	125.04	145.21
$t = 3$	Working	66	77.84	95.27	115.67	136.67
	Not Working	1661	75.99	89.69	110.21	130.26
	On UB	1227	75.92	89.80	110.08	130.09
	Not Working, Not on UB	468	76.37	90.38	111.19	131.29
	All	1727	76.10	89.97	110.59	130.53
$t = 15$	Working	695	111.02	125.43	148.35	171.12
	Not Working	1032	79.53	93.80	115.01	135.52
	On UB	107	85.70	98.10	119.47	138.08
	Not Working, Not on UB	925	78.95	93.07	114.50	135.24
	All	1727	89.50	103.95	125.31	146.70

It is also interesting to perform the simulations of the above variables for the case of no means testing of benefits, and to compare the figures with those of Table 3.6. In Table 3.7, the total household incomes are calculated as though every element of means testing were removed, although the distinction between UB and SB is retained, in the sense that the relevant payment rates at a given date apply. Thus, the differences between those entitled to and those not entitled to UB are entirely due to the rates of the two payment types. Again, it is noteworthy that the amounts paid under the UB and SB schemes are very similar at both $t = -1$ and $t = 3$, although the gap noted in Table 3.6 between benefit rates at the first and second interviews again makes a difference at $t = 15$.

Obviously, the first column of Table 3.7 is identical to the first of Table 3.6, since means testing has no implications if the wife is not working. It is the differences in the two tables between the columns for positive hours of work of the wives that indicate the effect of means testing on household income. A striking point is the extent to which means testing also affects households headed by working men. At all three dates, and for all positive hours of work of the wives, median household income for workers is higher in the absence of means testing. This is because HB can be received when working, but is means tested against the wages of both spouses.

Secondly, the point made above about the incentives for men to take part-time jobs if they cannot find full-time ones is reversed when there is no means testing, in the sense that the difference in the median household income when the husband is working part-time compared to those not working is constant, and low, at about £6, across the possible positive hours of work of his wife.

Tables 3.6 and 3.7 are interesting for the statistics they contain on the overall effect of means testing. It is, however, also instructive to examine some individual cases. An exercise calculating the total household income that would pertain for two hypothetical cases at 1987 benefit rates is contained in Dilnot and Kell (1989). One of their imaginary households contains two children aged between 11 and 15 years, where the husband is not entitled to receive UB, they pay £20 per week in rent and £5 per week in rates and the wife's gross hourly wage is £2.50. Their second hypothetical household has no children and the husband does qualify for UB, with the same rent, rates and gross wage rate of the wife.

The total income variables constructed as described above may be used to carry out a similar exercise, but using real cases. In order to make such an analysis comparable with Dilnot and Kell's, the *LSUS* data were inspected to find two actual situations which are as close to their hypothetical ones as possible. In one of the households selected, the wife's gross hourly wage rate is £2.55, the couple have two children aged 11 to 15, and the family rents a council house for £17.02 per week and pays rates of £8.65 per week. This household's financial position is portrayed in Table 3.8.

Table 3.8. Net income at different hours of work of wife at first interview; family with two children aged 11-15, husband not entitled to UB.

Income Source	Wife's Hours			
	None	P-T < 10	P-T > 10	Full-Time
Gross Wage	0	17.85	51.00	94.35
Tax and NI Deductions	0	0	-9.59	-26.50
SB Received	57.52	43.67	20.11	0
HB Received	25.67	25.67	25.67	14.21
Other Income	12.31	12.31	12.31	12.31
Net Income	95.50	99.50	99.50	94.37

This turns out to be a striking example of the effect of the discontinuities in the budget constraint as a result of the benefit system. The flat portion of the budget constraint for those households on SB only is clear - total household income is the same whether the woman works 7 or 20 hours. The £4 earnings disregard results in an increase in household income of that amount if she works part-time as opposed to not working. But most remarkable is the fact that total household income if the wife works full-time is *lower* than if she works part-time or if she does not work. This arises because if the wife works 37 hours per week, the husband's entitlement to SB is exhausted, so that the basis on which their HB is calculated changes from the 'certificated' system, under which all rent and rates are paid, to the 'standard' one. This results in the amount of HB received dropping by over £11 per week, with a drastic effect on household income. The disincentive to work is clear in this case; the average tax rate on part-time work is extremely high, while working full-time actually reduces the household's total resources. It may be of interest that this woman worked part-time, over ten hours at the first interview, despite the clear lack of incentive to do so.

The situation of the second household selected is given in Table 3.9. In this case, the wife's gross hourly wage is £2.65, the couple have no children, they pay rent of £21.55 per week, and no rates,⁷ and the husband is entitled to UB. The complexity of the interactions of the UB, SB and HB systems are clear here. If the wife works 7 hours per week, her UB dependant's allowance is withdrawn, so that her husband re-

ceives a slight increase in SB. If she works over 7 hours, his entitlement to SB is exhausted, and because of this, the basis of the calculation of their HB changes, so that the lower HB offsets the higher wage she is earning.

Table 3.9. Net income at different hours of work of wife, family with no children, husband entitled to UB.

Income Source	Wife's Hours			
	None	P-T < 10	P-T > 10	Full-Time
Gross Wage	0	18.55	53.00	98.05
Tax and NI Deductions	0	0	-10.36	-27.92
UB Received	40.45	25.00	25.00	25.00
SB Received	1.25	2.15	0	0
HB Received	21.55	21.55	13.19	3.69
Other Income	0.10	0.10	0.10	0.10
Net Income	63.35	67.35	80.90	98.87

In this situation, the disincentives to work are weaker than in the previous case, with an increase in household income of £35.52 if the wife changes from not working to working full-time; this amounts to an average 'tax' rate of 64% on working full-time, which is high, but does not entirely remove the financial incentives to work. In fact, this woman worked full-time at the time of the first interview.

3.5 The Effective Tax Rate Implied by the Means Testing of Benefits

One of the measures of the extent of the effect of means testing which was referred to in Section 1.3.1 was the effective average or marginal tax rate implied by the means testing of benefits. There, it was pointed out that the marginal tax rate imposed on household income by the benefit system for some range of income of the wife is 100% if her husband is on SB. This concept of the tax rate implied by means testing is used in this section to give an impression of the overall effect of means testing.

⁷ It seems probable that rent and rates are included in this figure.

The 'tax rate' variable is constructed by comparing the amount of benefit income that a household would receive in a given range of hours of work of the wife with that which they would receive in the absence of means testing,⁸ and expressing the 'loss' of household income because of means testing as a percentage of the wife's net wage at the relevant number of hours. Thus, this is a measure of the average rate at which the wife's contribution to household income is reduced by the means testing of UB, SB and HB.

One important point does arise from the fact that the tax rate variables are expressed as percentage losses of *net* income. The assumption that the tax liabilities of each couple are assessed separately implies⁸ that the income tax and NI payable by a wife do not vary with the income received by her husband; since, under joint taxation, a woman's net income may indeed vary with her husband's benefit status, allowing for the joint taxation of couples may change these calculations somewhat. However, I considered that this approximation was justified given the difficulties, referred to in Section 3.2.2, of calculating the tax payable by a woman whose husband's taxable income - his SB or UB - is itself dependent on his wife's post-tax income.

The median values of this variable for each date and for combinations of hours of work of the wife and job and benefit status of the husband are shown in Table 3.10. For the key date and the second interview, the means-testing tax rate for all those households where the head is working is zero, apart from that implied by HB, whereas at the first interview, when some men are working part-time, means testing affects income in a greater number of households.

Like Table 3.6, this table contains some surprising results. First, for those entitled to UB, at all three principal dates, high hours part-time work by the woman is the category that is most penalized. If only UB is received, then it should be low part-time hours that are most penalized, as the loss of the dependant's allowance should, on average, take effect in this hours range. Again this confirms the impression gained from Table 3.6 that the applicability of SB rules for those receiving both UB and SB means that high hours part-time work is also disadvantaged.

⁸ The benefit income received in the absence of means testing is always equal to the benefit income that would be received if the wife did not work, since this is the maximum household entitlement.

Table 3.10. Median of means testing tax rates, by wife's job status and husband's job status at the three principal dates. Figures in brackets give the 25% and 75% percentiles of the relevant variable's distribution.

Time	Husband's Actual Job Status	No. Obs.	Wife's Potential Job Status		
			P-T < 10	P-T > 10	Full-Time
$t = -1$	Working	1076	0.00 (0, .12)	0.00 (0, .17)	0.01 (0, .14)
	Not Working	651	0.59 (0, .72)	0.82 (.15, .88)	0.69 (.21, .90)
	On UB	106	0.60 (.45, .75)	0.71 (.57, .84)	0.59 (.45, .72)
	Not Working, Not on UB	519	0.58 (0, .72)	0.82 (.09, .88)	0.69 (.17, .90)
	All	1727	0.05 (0, .54)	0.09 (0, .67)	0.09 (0, .50)
$t = 3$	Working	66	0.54 (.13, .69)	0.55 (.31, .78)	0.46 (.22, .68)
	Not Working	1661	0.66 (.51, .74)	0.83 (.59, .88)	0.67 (.48, .89)
	On UB	1227	0.64 (.39, .74)	0.73 (.52, .87)	0.59 (.42, .74)
	Not Working, Not on UB	468	0.69 (.60, .74)	0.88 (.86, .89)	0.90 (.81, .92)
	All	1727	0.66 (.50, .74)	0.82 (.58, .88)	0.67 (.47, .89)
$t = 15$	Working	695	0.00 (0, .12)	0.00 (0, .12)	0.00 (0, .09)
	Not Working	1032	0.67 (.55, .73)	0.87 (.75, .89)	0.89 (.60, .92)
	On UB	107	0.62 (.39, .72)	0.77 (.52, .87)	0.62 (.47, .76)
	Not Working, Not on UB	925	0.67 (.56, .73)	0.87 (.82, .89)	0.90 (.70, .92)
	All	1727	0.43 (0, .70)	0.55 (.02, .88)	0.45 (.02, .91)

Secondly, for those whose husbands are entitled only to SB, full-time work is, at $t = 3$ and $t = 15$, taxed to an even greater extent than high part-time hours. Again, this reinforces the points made above that the extra SB entitlements of households due to mortgage interest payments extends the high level of SB means testing into the full-time hours range, and that the effect of changing from 'certificated' to 'standard' HB is very negative.

However, the table does confirm, as expected, that for almost all possible hours of work of the wife at the three principal dates, the median of the average implicit tax rate for UB recipients is markedly lower than for those qualifying only for SB. All differences in the medians are statistically significant, apart from that for working low part-time hours at the key date. At the first interview, the differences are significant at the 99% confidence level for all three hours ranges, as are those for high part-time and full-time work at the second interview; differences at other dates and in other hours ranges are significant at the lower 90% and 95% levels.



As to the absolute values of the variables, their medians are uniformly high, with a median 'loss' of net income of between 60% and 90%. A further point worth noting concerns the distribution of these tax rates around the median. The figures in brackets in Table 3.10, giving the 25% and 75% percentiles of the distribution of the variables indicate that even where the medians do not differ greatly between SB and UB recipients, the distribution around those medians tends to be tighter in the left tail for those receiving SB only than for those entitled to UB. Thus, for example, at the first interview, the difference in the means-testing tax rate for low-hours part-time work between households where the husband is receiving UB and those where he is not is 5 percentage points - 64% compared to 69%. However, the extra information about the distribution shows that the 25% percentile of the average tax rate is at 39% for those on UB, but at 60% for those not entitled to UB.⁹

Although the differences between the effects of different benefits on household income are not as clear-cut as might be expected from a textbook description of the benefit system, it may be concluded that there is a clear absence of financial incentives to work for the wives of the unemployed.

3.6 Attitudes to Work and the Means Testing of Benefits

In Section 2.5, data from the *LSU* survey on attitudes to work when a husband is unemployed were used to assess the extent to which the disincentive effect of means testing is appreciated by the women surveyed. In this section, the variables whose construction has been described above, and in particular the tax rate implied by means testing, discussed in the previous section, are used to establish the relationship between a woman's views on whether her husband's unemployment makes it more or less sensible for her to work and the reality of her financial situation.

Here, the responses as to the main reason for a woman viewing work as more or less sensible because of her husband's unemployment are used, as two of the possi-

⁹ Note that this pattern does not hold at the key date, where the 25% percentile is low for all hours of work; this is due to the high number of individuals on government training schemes whose payment for the schemes reduces their SB entitlement to zero.

ble reasons refer directly to financial motivations. One response is that a woman believes working to be more sensible because of a positive financial benefit, while the other is that she believes working to be less sensible because it is not worthwhile financially. Table 3.11 gives the median of average tax rates imposed by means testing for women who mention these motivations for their attitudes to work, for each possible hours range worked.

Table 3.11. Median tax rate implied by means testing at different hours of work for women who mention a financial motivation for their view on paid work.

Reason for View on Paid Work	Hours of Wife	First Interview (all women)	First Interview (if answer at second also)	Second Interview
Positive Financial Benefit	P-T<10	0.57	0.57	0.57
	P-T>10	0.69	0.70	0.69
	F-T	0.59	0.62	0.67
Not Worthwhile Financially	P-T<10	0.58	0.58	0.64
	P-T>10	0.78	0.77	0.84
	F-T	0.73	0.71	0.86

The table shows that women who believe working not to be worthwhile financially are more highly penalized for a given hours range at any one date. Thus, for example, at the first interview, the median rate at which those who believe that working is not worthwhile financially are taxed by the benefit system is 73%, compared to 59% for those who believe working to have a positive financial benefit. In other words, their beliefs appear to be reflecting their actual financial situations.

Having said this, however, it is remarkable that women who believe working to have a positive financial benefit are still affected so strongly by means testing. Between 57% and 70% of their net income is withdrawn because of means testing, and yet they still mention a positive financial benefit from working. This result casts some doubt on the extent to which the unmistakably strong disincentives in the system are the primary determinants of the opinions of the wives surveyed; it seems likely that these answers are reflecting differences in wage-earning potential rather than means-testing disincentives.

Another point about this tabulation is that for both attitudes to work, there is very little effect on the median means-testing tax-rate at the first interview when those

whose husbands return to work by the second interview are excluded, indicating that the 'type' of the woman does not determine the correlation between how much she is affected by means testing and her perception of the benefits of working.

Finally, it is interesting to note that when an equivalent tabulation is made for absolute values of household income lost due to means testing, as opposed to average means testing tax rates, the same patterns do not arise. In fact, there is no systematic difference in the amounts lost between the two attitude groups. This seems to indicate that the women react more to the *percentage* of their wage income which is 'lost' because of means testing than to the absolute amount lost.

3.7 The Assumptions Behind the Household Income Variable

Both the construction of variables for total household income, and the analysis of such variables for evidence of the effect of means testing on income and hence on the extent of disincentives to work for wives of unemployed men implicitly entail some important assumptions about the way women make their labour supply decisions. In this section, the assumptions underlying much of the analysis in the thesis are made explicit and their validity discussed.

Probably the most important assumption made here and throughout the thesis is that all household income is pooled. The very fact that the variable constructed is total *household* income implies that it is household income that is regarded as important by the wives of the unemployed, rather than income personally received. Indeed, the motivation for studying the wives of the unemployed, or indeed for the means testing of benefits by the government are void if household income is not pooled, at least to some extent, so that the benefit income received by a woman's husband and the wife's wage income are both important for all members of the household.

Some sociological evidence as to whether the assumption of complete pooling is valid is given in Pahl (1989). Here, the money management systems used within households are classified into four types. Of the 102 couples interviewed in the study, 56% pool their resources, and 9% keep their respective incomes entirely separate and split expenses between them, although not necessarily equally. In the remaining households, two types of intermediate system are used. 22% use the 'allowance' system,

whereby the husband gives a fixed amount of money to the wife each week for spending on the housekeeping and for her personal spending, to which she adds her wages, if any. The other 14% use the 'whole wage' system, where a husband gives his whole wage to his wife and she allocates personal spending money to him.

Thus, in 91% of these households, there is some sharing of money, although only in 56% is there complete pooling. There is reason to believe that in low income households, women have access to household income to a greater extent than in higher income households, since the 'whole wage' system is more used and the 'allowance' system less used at lower income levels, while shared management is equally prevalent at all income levels.

However, there may be a difference between the degree of access to money earned by a husband in theory and the utility gained from that money in practice, particularly if spending that money has to be justified to the husband. Thus, Pahl found that among couples who pooled their money, 38% of the wives felt that they had to justify spending the pooled money, whilst just 26% of the husbands felt this restriction.

The hypothesis of income pooling is difficult to test in a more formal manner than in Pahl's study because of the absence of data on intra-household allocation of resources. However, Lundberg *et al.* (1997) use a policy change in 1977-79 in the UK as a natural experiment to test the pooling hypothesis. Here, child benefit was changed from a tax relief on the father's wage income to a cash payment, normally to the mother. Under the pooling hypothesis, this redistribution of income from husband to wife should have no effect on expenditure patterns. Using aggregated data on consumption patterns from the FES for 1973-90, however, they find that the ratio of both children's and women's clothing to men's clothing expenditure is significantly affected by dummies for different family sizes in the post-policy change period, indicating an increase in spending on both children's and wives' clothing which is not compatible with complete pooling.

Given the doubts that are clearly justified about the prevalence of income pooling, it is treated as a testable hypothesis where possible in the later chapters of this thesis, rather than as an assumption.

The second important assumption made, mentioned in Section 3.1, is that the wife's labour force decision is exogenous to that of the husband. This means that the husband is assumed not to take his wife's labour supply decision into account in making his own, whilst the wife does consider her husband's labour supply in making her decision; this model is dubbed the 'Male Chauvinist' model of female labour supply by Killingsworth (1983).

In general, this is not a very appealing constraint to impose, although it is the most usual result found in empirical analyses of male labour supply where it is not imposed, but tested (see Pencavel, 1986). In the present situation, however, such results need to be relied on to a lesser extent than usual, since a substantial number of men in the *LSUS* sample are out of work at each of the three principal dates, and can therefore be assumed to be genuinely constrained in their labour supply.

A third assumption made is that women choose their hours of work from three broad groupings - full-time, part-time, over ten hours and part-time, less than ten hours. This assumption is not entirely unrealistic. It has been argued in several places that there are strong reasons to believe that individuals decide on an acceptable range of hours and accept the first offer within this range. Blundell and Laisney (1988) cite institutional reasons as causing only certain hours of work to be offered in the French labour market. Dickens and Lundberg (1993) model the labour supply decision as a choice among a set of jobs, each offering a fixed quantity of hours, and suggest that the validity of the model of labour supply that assumes free choice of hours requires sufficient mobility between jobs. Ilmakunnas and Pudney (1989) mention both institutional and technical reasons for hours grouping in Finland, and suggest that in many cases the only way to change hours of work is to change job, which is costly, particularly if the desired hours of work are outside the usual hours ranges, so that many individuals are likely to be observed out of equilibrium. Zabalza *et al.* (1980) also emphasize this point about the costs of changing jobs in order to adjust hours worked, noting that, in their British data set, hours worked are not bunched at kinks in the budget constraint, as would be expected if continuous adjustments were possible. Thus, the grouping of hours may be seen as a convenient way of accounting for optimization errors.

The use of the *LSUS* data requires this assumption about hours grouping, but the particular assumptions made about the hours worked within each range - 37 for full-time work, 20 for high part-time hours and 7 for low part-time hours - are open to question. This must be borne in mind in interpreting results.

Finally, the full take-up of all benefits is assumed in the calculation of the total household income variables, and throughout the thesis. Several studies have shown that this is certainly an unrealistic assumption. Using 1984 data from the FES, Fry and Stark (1989) estimate an SB take-up rate of 81% for non-pensioners, while Blundell, *et al.* (1988) use the same data to estimate a take-up rate of standard HB of 60%. For both studies, non-take-up is found to be significantly related to both income and the level of entitlement.

The alternative to the assumption of full take-up, however, would be the prediction of the take-up of benefits for each household for hours not actually worked by the wife, and the acceptance of the responses about receipt for the observed hours range of the wife. This would be problematic, since the system of housing benefit, for which take-up is clearly the greatest problem, was in the process of being changed at the time of the first interview of the *LSU* survey. Thus, the new system was not understood by all recipients and the reported figures are therefore unreliable. The decision was therefore taken to assume full take-up in preference to its prediction. To the extent that women make decisions in the knowledge that there is a safety net that they can use if necessary, the assumption of full take-up is not inappropriate.

3.8 Conclusions

In this chapter, the construction of variables for household income in various labour market states of the wife has been detailed, and the resulting variables judged to be appropriate for the representation of the effect of means testing on household income. Some surprising results emerging from the analysis of these income variables include:

- For the wives of men receiving only SB, the increase in median household income when hours increase from 20 hours per week to 37 hours per week is lower than expected, and not much more than the increase in median income when hours increase from 7 hours per week to 20 hours per week, for example. I concluded that

this is the result of the effect of the change in the basis on which HB is calculated to a less favourable one when SB entitlement is exhausted.

- For the wives of men receiving UB, there is no noticeable effect on household income at around the point where the dependant's allowance is withdrawn, at around 7 hours per week. I concluded that this is because of the high number of UB receivers also receiving SB.

Two families were chosen from the *LSUS* data, and their benefit entitlements examined, revealing striking disincentives to work, particularly for a woman with children and in rented accommodation whose husband is not entitled to UB.

The effective average tax rates implied by means testing for each hours of work range was also calculated; again the analysis of these variables indicated the blurring of the lines of distinction between UB and SB receivers.

Women's perceptions of the financial benefits of working were also analysed, and found to reflect, at least to some extent, the reality of their financial situations, as measured by the variables for the effective tax rates implied by means testing.

Finally, the assumptions of income pooling, the exogeneity of the wife's labour supply to the husband's, the choice between ranges of hours of work rather than a precise number of hours, and the full take-up of benefits were discussed and justifications for them advanced where possible.

4. A Fixed-Effects Model of the Labour Supply of the Wives of Unemployed Men

4.1 Introduction

In Chapter 2, the *LSUS* data were inspected for evidence in support of the various hypotheses advanced in Section 1.1 as reasons for the absence of an added worker effect in aggregate data. Many of the features of the data noted there support the importance of one particular explanation - the 'similar characteristics' hypothesis, which suggests that, because of assortative mating, husbands and wives share characteristics that explain the patterns of labour market behaviour observed for both of them. These data features include:

- The wives of men who exit their unemployment spells before the second interview are more likely to be added workers, as shown in Tables 2.8 and 2.9.
- Even before their husbands' unemployment spells began, women married to men whose unemployment spells were shorter had higher rates of employment; again, this is clear from Tables 2.8 and 2.9.
- Women who worked before their husbands' sampled unemployment spells began show different labour market response patterns to that unemployment than those who did not work. In particular, they are more likely to be movers, so they are more likely to react to the unemployment at all. These points are indicated by Tables 2.4 to 2.7.

One possible explanation for these features of the data, and one that is the focus of this chapter, is that women have characteristics that are persistent over time which determine their labour force behaviour; these characteristics may well be shared with their husbands. According to this explanation, the third point noted above, that a woman's current labour market status apparently depends on the state previously occupied, may arise only because past labour market behaviour reflects the persistent un-

observable factors that actually determine behaviour. Controlling for these persistent individual-specific effects is the appropriate approach in this case.

In this chapter, an econometric model is employed in analysing the *LSUS* data which allows for the possibility that individual-specific effects that are constant over time - fixed effects - determine a woman's labour supply. An alternative to the incorporation of individual-specific effects into the model is the specification of a model of joint labour supply of husband and wife, with couple-specific effects. Such a model is not useful here because, to the extent that it can be accepted that unemployment implies rationing, the husbands in the *LSUS* data are constrained in their labour supply, so that a model that treats the simultaneous choice of hours worked by husband and wife as a free one is inappropriate. Rather, the husband's labour supply is better treated as given, and the decision of the wife in response to his labour supply modelled accordingly.

The econometric model in question is the multinomial fixed effects conditional logit (FECL) model. The binomial version of this model has become a standard textbook topic,¹ but the multinomial version, proposed by Chamberlain (1980) has been used in few instances. The FECL model is outlined in Section 4.2. Section 4.2.1 explains the problems with estimating a fixed-effects model when the dependent variable is discrete. Section 4.2.2 details the solution presented by Chamberlain. Section 4.2.3 outlines the advantages and disadvantages of applying the model, while Section 4.2.4 deals with the practical difficulties of doing so.

Having outlined the econometric theory behind the model, Section 4.3 discusses its specification. Section 4.3.1 presents the discrete choice utility model that underlies the econometric analysis and the variables that such a model suggests. The appropriateness of these variables for inclusion in the FECL model is also assessed. Section 4.3.2 discusses the inclusion and interpretation of both choice-specific and non-choice-specific variables in the FECL model.

In Section 4.4, the results of a conditional logit model which pools the data from all three principal dates without taking account of fixed individual effects, are

¹ See, for example, Greene (1997).

presented. This model is used as a benchmark against which the FECL results can be compared. Section 4.5 presents and discusses the results of the FECL model. Section 4.6 concludes.

4.2 The Fixed-Effects Conditional Logit Model

4.2.1 Fixed Effects in Discrete Choice Models

In the case of a model with a continuous dependent variable, fixed effects can be accounted for by including a dummy variable, α_i , for each individual, with linear regression yielding consistent estimates of the parameters of interest, β , as the number of individuals $N \rightarrow \infty$ for a fixed number of time periods, T . The estimates of the fixed effects themselves are not consistent, but in the linear case the α_i are independent of the β , so the inconsistency of the estimates of the incidental parameters, $\hat{\alpha}_i$, is not transmitted to the maximum likelihood estimates of β .

In fact, where the dependent variable is continuous, the necessity of estimating the fixed effects can be eliminated by regressing $y_{it} - \bar{y}_i$ on $x_{it} - \bar{x}_i$, where \bar{y}_i and \bar{x}_i are the average values of the dependent and independent variables for the individual. For $T = 2$, this is equivalent to first differencing the variables.

However, it is not the case for discrete choice models that the inclusion of individual-specific dummies will yield consistent estimates of the β , since the α_i are not independent of the β . For the binary case, where

$$\Pr(y_{it} = 1) = F(\beta x_{it} + \alpha_i)$$

and F is a cumulative distribution function such as the unit normal or logistic, Chamberlain (1980) shows that

$$\text{Plim}_{N \rightarrow \infty} \hat{\sigma}^2 = \frac{T-1}{T} \sigma^2,$$

so that, as shown by Hsiao (1986), for $T = 2$,

$$\text{Plim}_{N \rightarrow \infty} \hat{\beta} = 2\beta.$$

Clearly, the inclusion of individual-specific dummies is not appropriate in discrete choice models, at least when T is fixed.

4.2.2 Chamberlain's Fixed-Effects Conditional Logit Model

Chamberlain (1980) has outlined a method of eliminating fixed effects, α , in discrete choice models which does yield consistent estimates for a fixed number of time periods, T . His proposal is based on a suggestion made by Andersen (1970) for a consistent estimator of the parameters of interest, β , in the presence of the incidental parameters, α , for non-linear models. Andersen showed that if a minimum sufficient statistic s_i for the α exists that is not dependent on β , then maximizing the joint density of the y_i conditional on β and on the sufficient statistics s_i, \dots, s_N will give consistent estimates of the structural parameters, β .

For the logit model, such sufficient statistics exist, while they do not exist for the probit, for example. The sufficient statistics for the α for the logit model are:

$$s_{ij} = \sum_i w_{itj}, \quad (4.1)$$

where $w_{itj} = 1$ if $y_{it} = j$ and $w_{itj} = 0$ otherwise, y_{it} being the dependent variable for individual i at time t and the individual being observed in one of states $j = 1, \dots, J$. The conditional likelihood does not depend on the incidental parameters, so the α do not have to be estimated.

The example often given to illustrate the FECL model is the case of two time periods, $t = 1, 2$ and a binomial choice between states a and b at each date. Then, a sequence (a, b) entails $w_{11a} = 1$, $w_{11b} = 0$, $w_{12a} = 0$, and $w_{12b} = 1$. If $s_{1a} = 0$, then it must be the case that $s_{1b} = 2$, while if $s_{1a} = 2$, then $s_{1b} = 0$, so that for individuals who do not change state between the two dates, s_{1a} implies the value of s_{1b} and *vice versa*. Thus, only individuals with a sequence which entails $s_{1a} = 1$ and $s_{1b} = 1$ contribute to the likelihood function. The probability of observing a choice sequence (a, b) conditional on s_{ij} , for those individuals who contribute to the likelihood is:

$$\begin{aligned} \Pr[(a, b) | s_{1a} = 1, s_{1b} = 1] &= \Pr[(a, b) | (a, b) \text{ or } (b, a)] \\ &= \frac{\Pr[w_{11a} = 1] \cdot \Pr[w_{12b} = 1]}{\Pr[w_{11a} = 1] \cdot \Pr[w_{12b} = 1] + \Pr[w_{11b} = 1] \cdot \Pr[w_{12a} = 1]} \end{aligned}$$

Dropping the individual subscript and substituting the logistic function into the expression, this becomes

$$\begin{aligned}
 & \left[\frac{\exp(\beta x_1 + \alpha)}{1 + \exp(\beta x_1 + \alpha)} \cdot \frac{1}{1 + \exp(\beta x_2 + \alpha)} \right] \\
 & \left[\frac{\exp(\beta x_1 + \alpha) + \exp(\beta x_2 + \alpha)}{[1 + \exp(\beta x_1 + \alpha)] \cdot [1 + \exp(\beta x_2 + \alpha)]} \right] \\
 & = \frac{\exp(\beta x_1 + \alpha)}{\exp(\beta x_1 + \alpha) + \exp(\beta x_2 + \alpha)} \\
 & = \frac{1}{1 + \exp[\beta[(x_2 + \alpha) - (x_1 + \alpha)]]} \\
 & = \frac{1}{1 + \exp[\beta(x_2 - x_1)]} \tag{4.2}
 \end{aligned}$$

Similarly, it can be shown that

$$\Pr[(b, a) | (a, b) \text{ or } (b, a)] = \frac{\exp[\beta(x_2 - x_1)]}{1 + \exp[\beta(x_2 - x_1)]} \tag{4.3}$$

In this case, the FECL model reduces to a binomial logit model estimated only over those who make transitions, with an individual's outcome coded one if her transition is (b, a) and coded zero if the transition is (a, b) , and with the explanatory variables entered as differences.

The above two period, binomial choice case demonstrates the logit equivalent of first differencing to eliminate fixed effects in the linear model. However, this case is not very general. For the *LSUS* data, there are more than two time periods and more than two choices of state. Moreover, for reasons that become clear in Section 4.3.1, a model with choice-specific variables is appropriate. Such a case is detailed here; other cases are outlined in Appendix B.

With three time periods, $t = 1, 2, 3$ and three states, $j = a, b, c$, an observed sequence of (a, b, b) implies that $w_{11a} = 1$, $w_{11b} = 0$, $w_{11c} = 0$, $w_{12a} = 0$, $w_{12b} = 1$, $w_{12c} = 0$, $w_{13a} = 0$, $w_{13b} = 1$ and $w_{13c} = 0$. Hence, $s_{1a} = 1$, $s_{1b} = 2$, $s_{1c} = 0$. Then

$$\begin{aligned}
\Pr[(a,b,b)|s_{1a}=1, s_{1b}=2, s_{1c}=0] &= \Pr[(a,b,b)|(a,b,b) \text{ or } (b,a,b) \text{ or } (b,b,a)]^2 \\
&= \frac{\Pr[w_{11a}=1] \cdot \Pr[w_{12b}=1] \cdot \Pr[w_{13b}=1]}{\left[\Pr[w_{11a}=1] \cdot \Pr[w_{12b}=1] \cdot \Pr[w_{13b}=1] + \Pr[w_{11b}=1] \cdot \Pr[w_{12a}=1] \cdot \Pr[w_{13b}=1] \right. \\
&\quad \left. + \Pr[w_{11b}=1] \cdot \Pr[w_{12b}=1] \cdot \Pr[w_{13a}=1] \right]} \\
&= \frac{\left[\frac{\exp(\beta x_{1a} + \alpha) + \exp(\beta x_{2b} + \alpha) + \exp(\beta x_{3b} + \alpha)}{[\exp(\beta x_{1a} + \alpha) + \exp(\beta x_{1b} + \alpha) + \exp(\beta x_{1c} + \alpha)] \cdot [\exp(\beta x_{2a} + \alpha) + \exp(\beta x_{2b} + \alpha) \right.} \\
&\quad \left. + \exp(\beta x_{2c} + \alpha)] \cdot [\exp(\beta x_{3a} + \alpha) + \exp(\beta x_{3b} + \alpha) + \exp(\beta x_{3c} + \alpha)] \right]}{\left[\frac{[\exp(\beta x_{1a} + \alpha) \cdot \exp(\beta x_{2b} + \alpha) \cdot \exp(\beta x_{3b} + \alpha)] + [\exp(\beta x_{1b} + \alpha) \cdot \exp(\beta x_{2a} + \alpha) \right.} \\
&\quad \left. \cdot \exp(\beta x_{3b} + \alpha)] + [\exp(\beta x_{1b} + \alpha) \cdot \exp(\beta x_{2b} + \alpha) \cdot \exp(\beta x_{3a} + \alpha)]}{[\exp(\beta x_{1a} + \alpha) + \exp(\beta x_{1b} + \alpha) + \exp(\beta x_{1c} + \alpha)] \cdot [\exp(\beta x_{2a} + \alpha) + \exp(\beta x_{2b} + \alpha) \right.} \\
&\quad \left. + \exp(\beta x_{2c} + \alpha)] \cdot [\exp(\beta x_{3a} + \alpha) + \exp(\beta x_{3b} + \alpha) + \exp(\beta x_{3c} + \alpha)] \right]} \\
&= \frac{\exp[\beta(x_{1a} + x_{2b} + x_{3b}) + 3\alpha]}{\exp[\beta(x_{1a} + x_{2b} + x_{3b}) + 3\alpha] + \exp[\beta(x_{1b} + x_{2a} + x_{3b}) + 3\alpha] + \exp[\beta(x_{1b} + x_{2b} + x_{3a}) + 3\alpha]} \\
&= \frac{\exp[\beta(x_{1a} + x_{2b} + x_{3b})]}{\exp[\beta(x_{1a} + x_{2b} + x_{3b})] + \exp[\beta(x_{1b} + x_{2a} + x_{3b})] + \exp[\beta(x_{1b} + x_{2b} + x_{3a})]} \quad (4.4)
\end{aligned}$$

Similarly,

$$\begin{aligned}
\Pr[(b,a,b)|(a,b,b) \text{ or } (b,a,b) \text{ or } (b,b,a)] &= \\
&= \frac{\exp[\beta(x_{1b} + x_{2a} + x_{3b})]}{\exp[\beta(x_{1a} + x_{2b} + x_{3b})] + \exp[\beta(x_{1b} + x_{2a} + x_{3b})] + \exp[\beta(x_{1b} + x_{2b} + x_{3a})]} \quad (4.5)
\end{aligned}$$

$$\begin{aligned}
\Pr[(b,b,a)|(a,b,b) \text{ or } (b,a,b) \text{ or } (b,b,a)] &= \\
&= \frac{\exp[\beta(x_{1b} + x_{2b} + x_{3a})]}{\exp[\beta(x_{1a} + x_{2b} + x_{3b})] + \exp[\beta(x_{1b} + x_{2a} + x_{3b})] + \exp[\beta(x_{1b} + x_{2b} + x_{3a})]} \quad (4.6)
\end{aligned}$$

$$\begin{aligned}
\Pr[(c,b,b)|(c,b,b) \text{ or } (b,c,b) \text{ or } (b,b,c)] &= \\
&= \frac{\exp[\beta(x_{1c} + x_{2b} + x_{3b})]}{\exp[\beta(x_{1c} + x_{2b} + x_{3b})] + \exp[\beta(x_{1b} + x_{2c} + x_{3b})] + \exp[\beta(x_{1b} + x_{2b} + x_{3c})]} \quad (4.7)
\end{aligned}$$

² The possible sequences with $s_a = 1$ are: (a,b,b) , (a,c,c) , (b,a,b) , (c,a,c) , (b,b,a) , (c,c,a) , (a,b,c) , (a,c,b) , (b,a,c) , (c,a,b) , (b,c,a) and (c,b,a) . Those with $s_b = 2$ are: (a,b,b) , (c,b,b) , (b,b,a) , (b,b,c) , (b,c,b) and (b,a,b) . Those with $s_c = 0$ are: (a,b,b) , (b,a,b) , (b,b,a) , (b,a,a) , (a,b,a) and (a,a,b) . Thus, the sequences that satisfy all three conditioning requirements are (a,b,b) , (b,b,a) and (b,a,b) .

and so on.

At first glance, the likelihood contribution of any individual appears similar to that in a multinomial logit model with a *sequence* of choices as the dependent variable, rather than the choice at one date. But the alternatives over which the denominator is summed are different than would be the case if such a model were estimated, since some potential choice sequences are excluded; here only those sequences with the same s_{ij} as the observed sequence are included in the denominator. This leads to the following log likelihood function:

$$L = \sum_i \ln \left(\frac{\exp \left(\beta \sum_{i,j} x_{ij} w_{ij} \right)}{\sum_{d \in B_i} \exp \left(\beta \sum_{i,j} x_{ij} d_{ij} \right)} \right) \quad (4.8)$$

where

$$B_i = \left\{ d = (d_{11}, \dots, d_{TJ}) \mid d_{ij} = 0 \text{ or } 1; \sum_j d_{ij} = 1; \sum_i d_{ij} = s_{ij} \right\}$$

is the set of sequences with the same s_{ij} as the one chosen by individual i . The maximization of this expression yields consistent estimates of the β parameters.

The binomial version of the FECL model has been applied in several cases in the literature, by Björklund (1985) to mental health, by Cecchetti (1986) to price increases and by Giannelli and Micklewright (1995) to the labour force participation of married women. The multinomial model has been applied by Börsch-Supan (1990) and Börsch-Supan and Pollakowski (1990) to housing choices, in terms of both size and tenure, and by Rosenzweig and Wolpin (1994) to the choice by the parents of single mothers as to whether to make transfers to them and/or choose co-residence with them.

4.2.3 Advantages and Disadvantages of the Fixed-Effects Conditional Logit Model

The above description of the fixed effects conditional logit model is useful for understanding some desirable and undesirable features of the model. First, it should be noted that only those who make a transition contribute to the likelihood function, so that information on those who make no transition is not used. Thus, if there is no heteroge-

neity, the estimator is inefficient. The appropriate test for heterogeneity is discussed in Section 4.5.2.

Secondly, time invariant variables are differenced out, so that their effects cannot be estimated. This turns out to be an important restriction on the variables which may validly be included in the model, as discussed in Section 4.3.1.

Third, the model excludes the possibility of true state dependence; this can be seen using the example of the multinomial FECL described by Equations 4.4 to 4.7. There it was shown that

$$\begin{aligned} & \Pr[(b,a,b)|(a,b,b) \text{ or } (b,a,b) \text{ or } (b,b,a)] = \frac{\exp[\beta(x_{1b} + x_{2a} + x_{3b})]}{[\exp[\beta(x_{1a} + x_{2b} + x_{3b})]] + [\exp[\beta(x_{1b} + x_{2a} + x_{3b})]] + [\exp[\beta(x_{1b} + x_{2b} + x_{3a})]]} \\ & = 1 - \left[\frac{\exp[\beta(x_{1a} + x_{2b} + x_{3b})] + \exp[\beta(x_{1b} + x_{2b} + x_{3a})]}{[\exp[\beta(x_{1a} + x_{2b} + x_{3b})]] + [\exp[\beta(x_{1b} + x_{2a} + x_{3b})]] + [\exp[\beta(x_{1b} + x_{2b} + x_{3a})]]} \right] \\ & = 1 - \Pr[(a,b,b)|(a,b,b), (b,a,b) \text{ or } (b,b,a)] - \Pr[(b,b,a)|(a,b,b), (b,a,b) \text{ or } (b,b,a)] \end{aligned}$$

This means that the effect of a variable on the probability of having a particular sequence of transitions is constrained by its relationship with other transition sequences which entail the same sy , rather than being determined by the initial state. This can be seen very clearly in the case of the two period binomial model of Equations 4.2 and 4.3, the effect of a variable on the probability of a transition from a to b is constrained to be the opposite of its effect on the probability of a transition from a to b , since

$$\Pr[(a,b)|(a,b) \text{ or } (b,a)] = 1 - \Pr[(b,a)|(a,b) \text{ or } (b,a)].$$

The difficulty of estimating a model that accounts both for fixed individual effects and state dependence is discussed in Section 5.2.1.

There is an alternative to the assumption that the individual-specific effects are fixed. This is that the α are a random sampling from a standard normal distribution, in which case the appropriate model is the random effects probit one. *A priori*, this is a more attractive model than the fixed effects one, since it does not involve discarding data, and it is more consistent to treat both the error term and the individual effects as random, rather than treating one type of unknown as random and the other as fixed.

However, there are two issues that arise that militate against its use in this context. First, whereas in the fixed effects model, there is no restriction on the correlation between α_i and x_{it} , in the random effects model the form of any correlation must be specified; the model is realistic only if the possible correlation between α_i and x_{it} is accounted for, which entails making assumptions about the form of the relationship between them, typically that

$$\alpha_i = \sum_{t=1}^T \gamma x_{it} + \eta_i,$$

so that $E(\alpha_i | x_i)$ is linear, and η_i is normally distributed and independent of x_i . Thus, the assumption that the α_i are fixed is replaced with an assumption about the functional form of the relationship between the α_i and the x_i , which does not appear to be any more attractive. And secondly, the difficulties of estimating a multinomial probit model, due to the necessity of calculating multiple integrals, are well known.

4.2.4 Applying the FECL Model to the Multinomial Case

It is clear from the specification of the likelihood function for the multinomial FECL model, given by Equation 4.8, that the number of terms which must be calculated in the denominator increases geometrically with both the number of choices, J , and the number of time periods, T . It can also be shown that the computational burden increases in J faster than in T . For example, for $J = 3$ and $T = 3$, up to six terms must be calculated for the denominator, whilst a model with $J = 4$ and $T = 3$ requires the calculation of up to eighteen terms and one with $J = 3$ and $T = 4$ means calculating up to twelve terms per individual.

The complexity of the likelihood function has meant that routines for the estimation of binomial FECL models with many time periods ($T > 6$), or of any multinomial FECL models, have not been included in the commonly available statistical software.³ Although very recently, a powerful recursive algorithm for the maximization of the conditional likelihood has been applied to the fixed effects model,⁴ making the es-

³ Hence, Giannelli and Micklewright (1993) propose the use of an alternative, non-minimal sufficient statistic for the α_i which allows the estimation of a binomial model with many periods using common software packages.

⁴ In STATA 5.0, released in September, 1996.

timization of the model for long panels feasible, to date this algorithm has been used only for the extension of the binomial model to more periods rather than to more states, so for the purposes of this thesis, it is necessary to program the contribution of the likelihood for each individual for the particular case of $J = 4$ and $T = 3$. This program, used with *STATA*'s *ml* maximum likelihood maximization routine, is included in Appendix C.

4.3 Model Specification and Interpretation

4.3.1 Model Specification

The economic model underlying a discrete choice specification of labour market behaviour of married women is:

$$u_{ijt} = f(y_{ijt}, l_{ijt}^w, l_{it}^h, z_t) \quad (4.9)$$

where u_{ijt} is the utility of the wife at time t and in labour market state j , y_{ijt} is total household income at time t and in state j of the wife, l_{ijt}^w is the leisure of the wife in state j , l_{it}^h is the number of hours of leisure of the husband, and z_t is a vector of personal and household demographic characteristics.

In order to focus on the effects of different types of household income on utility, total household income at time t and in labour market state j of the wife may be usefully decomposed as follows:

$$y_{ijt} = y_{ijt}^{end} + y_{it}^{ex}$$

where y_{ijt}^{end} is that part of household income which is endogenous to the wife's labour supply, and y_{it}^{ex} is the household income exogenous to the wife's labour supply.

y_{ijt}^{end} can be further divided into the part of endogenous income that the wife receives, $y_{ijt}^{end(w)}$, essentially her wage income in state j plus any unemployment payments to which she is entitled if not working,⁵ and the part that the husband receives, $y_{ijt}^{end(h)}$, which amounts to any means-tested benefit income paid to him, including the

⁵ Recall from Section 3.4 that any unemployment payments to the wife are treated as exogenous to the husband's entitlement to benefits.

UB dependant's allowance, SB and HB, where receivable. The advantage of this further decomposition of endogenous income is that it allows a focus on means-tested income. If there is complete intra-household income sharing, then $y_{ij}^{end(h)}$ and $y_{ij}^{end(w)}$ should have equal effects on a wife's labour supply.

The income components which are exogenous to the wife's labour supply may also be decomposed further in order to allow a focus on the effects of benefits, and, by using a comparison with $y_{ij}^{end(h)}$, on any difference between the effects of means-tested and non-means-tested benefits:

$$y_i^{ex} = y_i^{ex(ben)} + y_i^{ex(nly)}$$

where $y_i^{ex(ben)}$ is exogenous income coming from unemployment payments, which amounts to the part of UB which does not depend on the wife's labour supply and $y_i^{ex(nly)}$ is other exogenous income, which includes the husband's wage income, if any, and other household non-labour income such as interest from savings, child benefit and FIS. Thus, some benefit income - that which is not related to the husband's unemployment - is included in $y_i^{ex(nly)}$. The components of y_i^{ex} are defined in this way so that $y_i^{ex(nly)}$ is comparable with the definition of the wife's non-labour income that is usually used in studies of female labour supply.

In considering the wives of the unemployed, the specification of utility which is of particular interest is, therefore:

$$u_{ij} = f(l_{ij}^w + l_i^h + y_{ij}^{end(w)} + y_{ij}^{end(h)} + y_i^{ex(ben)} + y_i^{ex(nly)} + z_i) \quad (4.10)$$

However, an examination of the likelihood function given by Equation 4.8 makes it clear that, since the denominator of the relevant likelihood function is summed across the choices, j , non-choice-specific variables fall out of the probability. Note that y_i^{ex} , l_i^h and z_i do not vary with the choice of state, y_i^{ex} by definition, the demographic characteristics because they are individual-specific and the leisure of the husband because it is assumed that the wife's labour supply is exogenous to the husband's labour supply decision, so the husband's labour supply is fixed at the actual number of hours observed; it does not vary according to the wife's labour supply.⁶ On the other hand,

⁶ This assumption is discussed in Section 3.7.

both endogenous household income, y_{ij}^{end} , and the leisure of the wife, l_{ij}^w , are clearly choice-specific.

The solution which allows variables that do not inherently vary with the choices to be included, described in Greene (1997) and used, for example, in Börsch-Supan (1990), is to create a set of dummies for the choices and multiply them by each of the individual-specific variables. Of course, in this case, a set of interactions between one of the l_{ij}^w and the non-choice-specific variables must be omitted to avoid perfect multicollinearity in the model.

This leads to an estimated model of the form:

$$u_{ij} = f\left(y_{ij}^{end(w)} + y_{ij}^{end(h)} + l_{ij}^w \left[y_i^{ex(bem)} + y_i^{ex(nly)} + l_i^h + \mathbf{z}_i \right] \right) \quad (4.11)$$

where $y_i = j$ if $u_{ij} > u_{ik}$ for all $k \neq j$. It is important to note that the choice-specific constant, l_{ij}^w , where not multiplied by another variable, drops out of the estimation. In a cross-section model of labour supply, this constant can be interpreted as the disutility of the hours of work associated with each regime. Here, assuming that the disutility of each regime is constant over time for any one individual, this effect becomes absorbed into the fixed effects, the α , which are not estimated. The possibility that the disutility of work changes over time can be allowed for; Börsch-Supan and Pollakowski (1990) do so, in the context of housing decisions, by including two choice-specific constants which summarize the 60 possible choice-specific alternative sequences.

A final point is that real values of all money variables are used in each of the models presented in Sections 4.4 and 4.5 below; the real values are obtained using the relevant values of the consumer prices index.

The terms which enter Equation 4.11 directly are interpreted as having a direct effect on utility; thus, both $y_{ij}^{end(h)}$ and $y_{ij}^{end(w)}$ are expected to have positive coefficients, being income variables. On the other hand, the terms which must be interacted with the choice-specific constants l_{ij}^w are interpreted in terms of their effects on the utility the individual gets from being in a given state l_{ij}^w , and therefore in terms of the probability of being in that state. Thus, y_i^{ex} is expected to have negative coefficients for choices entailing positive hours of work and the coefficient on l_i^h may be either

positive or negative, depending on whether l_i^h and l_{ij}^w are complements or substitutes for the wife.

Specifying the model according to Equation 4.11 entails the assumption that income that is endogenous to the wife's labour supply is separable from leisure, since the utility gained from y_{ij}^{end} does not depend on the number of hours she works to generate that income. For the other income sources, the necessity of multiplying by the choice-specific constants so that they will not drop out of the estimation means that this assumption can be tested. If income and leisure are indeed separable, the results can be expected to show statistically indistinguishable coefficients for the effect of y_i^{ex} on the probability of working full-time, and its effect on working part-time, for example.

Table 4.1. Descriptive statistics for variables used in the fixed effects conditional logit model.

Variable	Mean (All)	Mean (FECL)	Standard Deviation	Between Group Standard Dev.	Within Group Standard Dev.
$y_{ij}^{end(w)}$ F-T	56.65	55.00	26.73	25.10	9.26
P-T>10	35.27	33.82	15.17	14.15	5.50
P-T<10	14.15	13.67	7.28	6.85	2.49
None	0.83	1.20	5.34	3.33	4.18
$y_{ij}^{end(h)}$ F-T	8.69	7.86	12.73	9.49	8.49
P-T>10	16.19	14.04	17.41	12.23	12.40
P-T<10	27.23	23.16	23.61	15.38	17.92
None	32.89	27.52	27.10	17.01	21.12
$y_i^{ex(ben)}$	6.90	7.00	11.20	4.64	10.19
$y_i^{ex(nly)}$	51.23	58.89	68.33	43.17	52.99
Wife's Age	36.1	36.8	10.94	10.93	0.47
(Wife's Age) ²	1434	1473	840.83	840.96	36.34
No. Children Aged 0-4	0.48	0.34	0.61	0.59	0.19
No. Children Aged > 4	0.84	0.82	1.02	1.00	0.22
Local Unemployment	14.02	13.76	3.31	3.22	0.76
Husband at Work	0.35	0.42	0.49	0.25	0.43

Notes: All columns refer to the subset of the data used for the FECL estimation, except Column 1, which refers to the whole sample. All money variables are measured in pounds.

Table 4.1 presents some summary statistics for the variables proposed for inclusion in the FECL model. Because the estimation of the effect of a variable in this

model requires variation both between individuals (between-group variation) and for a given individual over time (within-group variation), the table reports these sources of variation separately, as well as overall variation.

The between-group standard deviation is calculated as the standard deviation of \bar{x}_i , the average of x_{it} over time for each woman. The within-group measure is the standard deviation of $(x_{it} - \bar{x}_i + \bar{\bar{x}})$, where $\bar{\bar{x}}$ is the average over all observations; thus, it gives the variation of each woman's deviation from her mean.⁷ The means given in Column 2 are for the individuals used in the estimation of the FECL model, all of whom make at least one transition between principal dates, whilst those given in Column 1 are for all individuals in the *LSUS* data. Thus, a comparison of these columns indicates differences between the whole sample and the estimation sample.

The table raises several interesting points. First, if the degree of variation in $y_{ij}^{end(w)}$ is examined, it is clear that, for each hours range, there is very little within-group variation.⁸ This is because of the manner in which the wage variable must be constructed for those women not working at a particular date. As indicated in Section 3.2.1, in order to make the wage variable as accurate as possible, particularly given the absence of information on education levels, information on wage inflation was used to extrapolate the gross wage rate from dates at which a woman worked to dates at which she did not work. Since most women in the sample used in the estimation of Chamberlain's fixed effects model make transitions between working and not working rather than between working states, the within-group variation in wages is the same for many women, the variation having been generated using the rate of wage inflation. There is little genuine variation over time in the wage variables.⁹

A second variable for which Table 4.1 raises concerns is $y_i^{ex(bem)}$. Here, the between-group standard deviation is low, and the within-group measure accounts for much of the overall variation. The problem here is that this variable is very nearly a

⁷ $\bar{\bar{x}}$ is added to make the results comparable.

⁸ Its value for zero hours of work might be regarded as an exception; this is because of the addition of any unemployment payments received by the wife for this status.

⁹ 420 women make transitions of some kind between the key date and the second interview. Of these, 81 (19%) work at all three dates; these women are making transitions between working states. For these women, the variation over time is likely to differ from the rate of wage inflation.

dummy; apart from some small amount of allowances for children, it is identical for all those entitled to receive it. The implications of this for its inclusion in estimated models is returned to in Sections 4.4 and 4.5.

The most striking result included in the table, however, is the decomposition of the standard deviation for age. This variable has no within-group deviation. Although time-varying, age varies to exactly the same extent for each individual in the sample. Each individual is obviously one year older at the second interview than at the first, and has the same age at the first interview as at the key date. Age² does have some small degree of within-group variation, since its relationship with calendar time is non-linear, but this is a small component of the overall ε variation in the variable.

Clearly, age is not suitable for inclusion as a variable in an FECL model, since, in such a model it captures calendar time rather than that which it purports to represent. On the other hand, Börsch-Supan (1990), Börsch-Supan and Pollakowski (1990) and Rosenzweig and Wolpin (1994) all include age and its square as variables in FECL models, also using data sets with observations at fixed intervals. It is only because of the necessity of multiplying by choice-specific dummies, and the concomitant necessity to exclude the interaction between age and one of the choices, here 'not at work', to avoid perfect multicollinearity, that any variation in the contribution to the likelihood of individuals is generated, so that the model can be estimated. But even if the model can be estimated, the results for age are not meaningful.

The variables for the number of children also show little within-group variation. Clearly, the number of children in a certain age group varies little over time for a given woman. The time variation in these variables is generated by children leaving an age group by getting older, by children who are four years old at the first interview becoming five years old by the second, and, for the 'children aged 0-4' variable, by women giving birth. Finally, the local rate of unemployment does not, apparently, change significantly over time, its variation being dominated by the between-groups component.

In comparing the first two columns of the table, some indications of selectivity into the group over which estimation is carried out are evident. Women in the FECL sample have fewer pre-school children than in the whole sample, as might be expected,

since, by definition, all the women who make a transition during the survey period work at one of the principal dates. Moreover, the mean values for the 'husband at work' variables show that their husbands are less likely to be out of work, a point which is also reflected in their consistently lower average level of $y_{ij}^{end(h)}$. On the other hand, they also have a consistently lower level of potential wage income, $y_{ij}^{end(w)}$, indicating that the selectivity issue may not be important.

4.3.2 Model Interpretation

An important point concerns the interpretation of the estimates. As is the case for all non-linear models, the coefficient on a variable does not represent the marginal effect of an increase in the value of the variable. While it is possible to calculate the marginal effect of x_{ij} on the probability of having a given sequence of choices, say $P(a, b, b)$, this is not very useful for the interpretation of coefficients in a general way. Instead, the fact that the β are consistent estimates of the multinomial conditional logit coefficients when there is unobserved heterogeneity can be used. Since

$$P(y_i = j) = \frac{\exp(\beta x_{ij})}{\sum_j \exp(\beta x_{ij})}$$

$$\begin{aligned} \text{then } \frac{\partial P_{ij}}{\partial x_{ij}} &= \frac{\left[\sum_j \exp(\beta x_{ij}) \right] [\beta \exp(\beta x_{ij})] - [\exp(\beta x_{ij})] [\beta \exp(\beta x_{ij})]}{\left[\sum_j \exp(\beta x_{ij}) \right]^2} \\ &= \beta P_{ij} - \beta [P_{ij}]^2 \end{aligned} \quad (4.12)$$

$$\begin{aligned} \text{and } \frac{\partial P_{ij}}{\partial x_{ik}} &= \frac{-[\exp(\beta x_{ij})] [\beta \exp(\beta x_{ik})]}{\left[\sum_j \exp(\beta x_{ij}) \right]^2} \\ &= -\beta P_{ij} P_{ik} \text{ for } k \neq j. \end{aligned}$$

Note that the marginal effects for all states may be computed.

For non-choice specific variables, the coefficients are the same as would be obtained in a multinomial logit model, so their interpretation is based on:

$$\frac{\partial P_{ij}}{\partial x_{ij}} = \beta_j P_{ij} - \left[\sum_k \beta_k P_{ik} \right] P_{ij}. \quad (4.13)$$

Inspection of Equation 4.13 shows that, for non-choice-specific variables, the calculation of the marginal effects is particularly important because the sign on the coefficient may be reversed when the marginal effects are calculated, indicating that even the direction of the effect cannot be seen from the sign of the coefficient.

For non-choice-specific variables, since the normalization that $\beta_0 = 0$ is used, the marginal effects give the change in the probability of being in the relevant state compared to the probability of being in the benchmark state, $j = 0$. Typically, the benchmark state is the most commonly observed one, as is the case here, so the marginal effects reported in the remainder of the chapter are for the change in the probability of being in the relevant state compared to the probability of not working.

For both choice-specific and non-choice specific variables, the above partial derivatives are valid only for continuous variables. To calculate the effect of a dummy variable, the probability of being in a particular state, j , is calculated at the mean of the values of the other variables, with the dummy set equal to zero, and then with the dummy set equal to one; the difference in the probabilities then gives the effect of 'switching on' the dummy for the average woman.

4.4 Results from a Pooled Conditional Logit Model

Before presenting the results of the FECL model, the results from a pooled model of the labour supply of the wives of the unemployed men surveyed in the *LSUS* are outlined here. 'Pooling' entails combining the data on all individuals from all three principal dates. A multinomial conditional logit model is then estimated on these data. When a pooled model is used, no account is taken of the fact that there may be a correlation between the three observations contributed by each woman.

There are two reasons for estimating a pooled model as well as the FECL model. One is that it is useful for the purposes of comparison, to examine what changes, if any, are brought about by accounting for fixed individual effects. To this end, it would also be possible to run cross-section conditional logit models separately for each of the three principal dates. But the pooled model is useful for the further reason that, in the absence of heterogeneity, the FECL model is less efficient than the pooled one because it does not use the information that $\alpha = \alpha$, and it typically uses a

subset of the same data, and so it is the pooled model that is suitable for comparison using a Hausman test, as discussed in Section 4.5.2.

Table 4.2. Results for the pooled conditional logit model. Asymptotic *t*-statistics in brackets.

Non-Choice-Specific Variables	Full-Time		Part-Time > 10 Hours		Part-Time < 10 Hours	
	Coefficient (<i>t</i> -Stat.)	Marginal Effect	Coefficient (<i>t</i> -Stat.)	Marginal Effect	Coefficient (<i>t</i> -Stat.)	Marginal Effect
$y_i^{ex(ben)}$	0.0100 (2.10)	0.0010	0.0179 (3.94)	0.0021	0.0201 (2.86)	0.0008
$y_i^{ex(nly)}$	-0.0092 (-6.42)	-0.0013	-0.0039 (-3.58)	-0.0003	-0.0008 (-0.61)	0.0001
Wife's Age	0.2644 (7.88)	0.0308	0.3220 (8.52)	0.0370	0.1613 (2.97)	0.0038
(Wife's Age) ² ÷ 100	-0.3771 (-8.61)	-0.0457	-0.3759 (-8.03)	-0.0418	-0.1968 (-2.85)	-0.0044
Number Children Aged < 1	-2.4002 (-8.02)	-0.2940	-2.1862 (-5.18)	-0.2379	-1.3595 (-3.41)	-0.0346
Number Children Aged 1-4	-1.8498 (-13.59)	-0.2503	-0.7497 (-6.70)	-0.0633	-0.2351 (-1.84)	0.0063
Number Children Aged > 4	-0.7660 (-12.43)	-0.1086	-0.0943 (-2.02)	0.0020	0.0218 (0.32)	0.0069
Husband at Work	1.4901 (9.05)	0.1288	1.1689 (7.87)	0.1006	0.8647 (4.25)	0.0258
Husband's Bad Unemp. History	-0.0695 (-2.62)	-0.0089	-0.0596 (-2.25)	-0.0067	0.0056 (0.16)	0.0011
Constant	-6.1533 (-10.13)	-	-8.7105 (-11.87)	-	-6.2500 (-6.23)	-
Choice-Specific Variables	Coefficient	<i>t</i> -Statistic	Marginal Effects × 10 ²			
			F-T	P-T > 10	P-T < 10	None
$y_{ij}^{end(w)}$	0.0274	(13.31)	0.3376	0.3178	0.1252	0.6018
$y_{ij}^{end(h)}$	0.0004	(0.12)	0.0043	0.0041	0.0016	0.0077
No. Observations: 5111			Pseudo-R ² : 0.398		Log Likelihood: -4214.3	

Notes: All money amounts are in pounds. Marginal effects are calculated at the sample probability of occupying the relevant state. Here, $\Pr(FT) = 0.144$, $\Pr(PT > 10) = 0.134$ and $\Pr(PT < 10) = 0.048$.

The results of the pooled model are shown in Table 4.2. The first point to note about the model presented here is that it includes variables that are not time varying - in particular, it includes the number of times that the husband had been unemployed in the five years prior to his sampled unemployment spell, as well as the wife's age and its square. Since no account is taken of fixed effects here, there is no necessity for the

variables to vary with time. The model presented here was selected according to the results of a series of *LR* tests.

Income Variables

Whilst some of the results shown in the table conform to the expectations outlined in Section 4.3.1 above, others clearly do not. $y_i^{end(w)}$, the wage (and unemployment payment) income of the wife has a positive and highly statistically significant coefficient, indicating, as anticipated, that income received by the wife has a positive effect on her utility.

The marginal effects columns show that this income is also a fairly important determinant of a woman's labour supply. The marginal effects on full-time work and high part-time hours of work are of similar size, and indicate that, for an increase in wage income of £3 per week, and for a woman with the average probability of working either full-time or high part-time hours, the probability of her choosing the relevant hours range increases by about 1 point. For a woman working part-time, this entails a larger proportional increase in her wage than for a full-time worker, but it is, nonetheless, a relatively small increase required to induce this effect. The effect of wage income on the average woman's probability of working low part-time hours is smaller, with a £7 increase in weekly income required to increase her probability of working in this hours range by 1 percentage point, which is, proportionately speaking, a large increase in wage income. But this is a result of the construction of the model, in particular the assumption implicit in the use of one choice-specific variable for wage within a conditional logit structure, that income and leisure are separable, a point which was discussed in Section 4.3.1; this must be taken into account in interpreting these results. The effect of an increase in the income to the wife when not working on the probability of not working is larger; giving £2 to a woman who has the average probability of not working to stay out of the labour force increases her probability of not working by over 1 point.

The wage income a woman receives has the expected effect on labour supply. On the other hand, means-tested benefit income received by the husband but determined by his wife's labour supply, $y_i^{end(h)}$, appears to have no effect on the labour supply of the wife. The coefficient is positive, but completely insignificant.

A possible explanation for this result is that unobserved individual effects are counteracting the effect of means-tested benefit income on labour supply. This explanation would suggest that the higher utility from higher income is offset by the fact that men who receive more means-tested benefit income at the first interview are those who do not qualify for UB, and are likely to be less attached to the labour market, and by extension, if their wives share these characteristics, they get greater than average disutility from working. Since this unobserved 'taste for work' is controlled for in the FECL model, it can be expected that this result will not hold in that model.

By the same token, the results for $y_{ij}^{end(w)}$ may over-state its effect. For wages, the unobserved taste factor works in the same direction as the positive effect of income on utility, since women with higher taste for work may both earn higher wages *and* be more likely to be observed working, all other things being equal. Thus, a reduction in the importance of $y_{ij}^{end(w)}$ may be expected in the results of the FECL model.

The positive effect of unemployment benefit income that is not means-tested, $y_i^{ex(ben)}$, is also unexpected. In this case, the points raised in Section 4.3.1 regarding the suitability of this variable for inclusion in an FECL model are relevant also to understanding this result. There, it was pointed out that this variable is effectively a dummy for the receipt of UB by the husband. This explains the positive effect reported in Table 4.2, even though *a priori* it is anticipated that the wife would regard this as unearned income, yielding a negative effect on the probability of working. In fact, this variable is capturing similarities in characteristics between husbands and wives, whereby men entitled to UB, and hence their wives, have better employment characteristics than those men not entitled to it.

The final income variable included in the model, non-labour income, $y_i^{ex(nly)}$, does show the expected sign, with significant negative effects on the probability of the wife choosing to work full-time or high part-time hours. The marginal effects show that the effect of this variable is relatively small in economic terms, although it is significantly different from zero.

Demographic Variables

Turning to the demographic variables, the age variables show that the older a woman is, the more likely she is to choose to work positive hours rather than zero hours. It is

important to note, however, that the effect of the age variable is quadratic, and in each case, the negative effect of age^2 begins to dominate well within the values of age observed in the sample. Thus, if a woman is aged over 35 years, she is *less* likely to work full-time than not at all, and less likely to work high or low part-time hours if she is over 43 and 41 years respectively.

The negative effects of the number of pre-school children in the household are large, particularly for the higher hours ranges, and strongly significant. As would be expected, the number of children aged under one year old has a larger effect than the number of children aged between one and four years, which in turn has a larger effect than the number of older children in the households; the negative effect of older children on the probability of working full-time is of a similar size to the effect of children aged one to four on the probability of working high part-time hours.

Husband's Labour Market History

The variable for the husband having had a bad history of prior unemployment also has a significant negative effect on the probability of the wife working in the higher hours ranges. The marginal effects of these variables indicate that the probability of a wife working these hours is reduced by up to 1 percentage point for every extra spell of unemployment that her husband has had in the five years prior to his sampled unemployment spell. The significance of this variable indicates the importance of similarities in characteristics between husband and wife in explaining the labour supply of the wives of the unemployed. It should be noted here that it does not seem likely that the difference in the effect on employment probabilities between a husband having had no spells of unemployment and having had one spell would be the same as that between four and five spells, for example. However, when changes are made to the specification in an attempt to reflect this likely non-linearity of the effect, the performance of the model is worse.¹⁰

¹⁰ In comparing non-nested models, the Akaike Information Criterion (*AIC*) is used. This is given by: $AIC = -L + K$, where L is the log likelihood and K is the number of parameters to be estimated. The preferred model is that for which the *AIC* is smallest.

Husband's Job Status

Finally, one of the most striking results of the table is the strong positive effect of the husband's being at work on the probability of the wife working. The marginal effects are very high, indicating that this dummy being 'switched on' increases the probability of the average woman of working full-time by nearly 13 points, and of her working high part-time hours by about 10 points. Since fixed effects are not accounted for in this model, it seems most likely that this result is due to strong similarities in characteristics between husbands and wives, rather than strong complementarity of leisure times, but it is not possible to distinguish between these two reasons using a pooled model.

4.5 Results from a Fixed-Effects Conditional Logit Model

4.5.1 Results

In order to disentangle the effects of the persistent characteristics that a woman has that determine her labour supply from the effects of changes in the household situation, fixed effects are accounted for using the FECL model. The results of that model are given in Table 4.3.

Income Variables

The most striking thing about these results is how similar they are, in qualitative terms, to the results of the pooled model presented in the previous section. For the income variables which are of greatest interest here, the results for endogenous income are very similar. $y_i^{end(w)}$ has a positive coefficient which is significant at all usual levels of confidence, albeit much less significant than for the pooled model. This lower level of significance is expected, as suggested in Section 4.4, since a pooled model is likely to overstate the importance of a wage variable.

The marginal effect of $y_i^{end(w)}$ on the probability of a woman choosing any of the hours ranges is very close to those detailed in the previous section. Thus, a £3-£4 rise in weekly income will increase a woman's probability of choosing full-time or high part-time hours by around 1 percentage point. Again, the rise in weekly income necessary to increase a woman's probability of working low part-time hours is much higher -

about £10, which entails a very large increase in hourly income. A £2 payment for not working will increase a woman's probability of choosing that state by about 1 point, however.

Table 4.3. Results for the multinomial fixed effects conditional logit model. Asymptotic t-statistics in brackets.

Non-Choice-Specific Variables	Full-Time		Part-Time > 10 Hours		Part-Time < 10 Hours	
	Coefficient (t-Stat.)	Marginal Effect	Coefficient (t-Stat.)	Marginal Effect	Coefficient (t-Stat.)	Marginal Effect
$y_i^{ex(nly)}$	-0.0079 (-2.57)	-0.0009	-0.0075 (-2.92)	-0.0008	-0.0086 (-2.69)	-0.0003
Dummy: Children Aged 0-4	-5.5705 (-3.80)	-0.1482	-3.9775 (-3.79)	-0.0099	-2.0098 (-2.50)	0.2028
Dummy: Children Aged > 4	0.7109 (1.07)	0.0471	0.0882 (0.15)	-0.0024	1.6106 (2.14)	0.0778
Local Rate of Unemployment	-0.0853 (-0.70)	-0.0090	-0.2133 (-1.82)	-0.0277	0.1166 (0.90)	0.0076
Husband at Work	1.8881 (4.83)	0.1288	1.6689 (5.02)	0.0030	1.3433 (3.30)	0.1318
Choice-Specific Variables	Coefficient	t-Statistic	Marginal Effects $\times 10^2$			
			F-T	P-T > 10	P-T < 10	None
$y_{ij}^{end(w)}$	0.0221	2.41	0.2722	0.2562	0.1009	0.4852
$y_{ij}^{end(h)}$	0.0006	0.07	0.0071	0.0067	0.0026	0.0126
Number of Observations: 420			Log Likelihood: -416.9			

Notes: All money amounts are in pounds. Marginal effects are calculated at the sample probability of occupying the relevant state: see the Notes to Table 4.2.

Again, the results for benefit income that is received by the husband but endogenous to the wife's labour supply, $y_{ij}^{end(h)}$, has an insignificant coefficient. There is no evidence here that women take the benefit income that their husbands receive into account at all when making their labour supply decisions.

It should be emphasized how surprising this result is. It indicates that the reason for the absence of the expected significant positive effect of $y_{ij}^{end(h)}$ on the wife's utility is not due to unobserved fixed effects, since even when the possible importance of such unobservables are accounted for, this income is not regarded by the wives of unemployed men as a factor in their labour supply decisions. The most likely reason for this is that there is less than full income pooling within the household.

Non-labour income, $y_i^{ex(nh)}$, has a negative effect on the probability of working in any of the positive hours categories, with statistically indistinguishable coefficients for all three hours of work ranges. This is interesting, as the separability of income and leisure is supported by this result, whereas in the pooled model, the coefficients on this variable increased with the hours of work entailed in the relevant labour market status. This indicates that unobservable fixed effects generate results that would lead to the rejection of the hypothesis of the separability of income.

As regards income variables, it should be noted that $y_i^{ex(bem)}$ is not included here, its exclusion not having been rejected by an *LR* test. This outcome may be the result of the lack of between-group variation in this variable referred to in Section 4.3.2. However, it is more likely that it is because the 'similar characteristics' that caused it to have a positive effect on the probability of working in the pooled model are taken account of in the FECL model. Nonetheless, taken with the insignificant result for $y_{ij}^{end(h)}$, this result indicates that the income her husband receives when unemployed is not a significant determinant of a woman's labour supply, perhaps because of expectations of the duration of the husband's unemployment.

Demographic Variables

One of the more interesting results of the FECL model is that the effect of the presence of pre-school children in the household is actually larger when fixed effects are taken into account than otherwise. The marginal effect of the presence of small children is such that this dummy decreases the probability of working full-time by almost 15 points, of working low part-time hours by about 20 points, and of working high part-time hours by about 1 point. In this model, dummies for the presence of children of different age groups are found to be better at explaining the labour supply decisions made than the number of children in each category, so the direct comparison of the results in Tables 4.2 and 4.3 is not valid. However, if Table D1 in the Appendix is used for comparison instead, since it reports the results for a pooled model that contains all of the variables included in the FECL model, then it is clear that the effect of the presence of children is estimated to be much larger using the latter.

It might be expected that accounting for unobserved persistent effects would decrease the estimated effect of children, since women with low taste for labour mar-

ket work may also have a high taste for having children. However, this result is one that is often obtained using fixed effects models, as discussed in Chamberlain, (1984, pp. 1304) and Maddala (1987, pp. 323). It is possible that this result is obtained because much of the within-group variation in the variable comes from the birth of children, as well as from children moving from the pre-school age group into the next age group; the probability of observing a woman in the labour force is surely much lower around the time of childbirth than for other mothers of young children. However, when the dummy for children aged up to four years old is split into dummies for children aged less than a year and another for those aged between one and four years, the results, which are not reported here, show that the effect of children aged between one and four years is still much stronger than that found in the pooled model.

The fact that the effect of the presence of children of school-going age becomes insignificant for high hours of work, and significantly positive for low part-time hours in the FECL model¹¹ shows that, in cross-section models, children in this age group have an effect on labour supply largely because of the taste for labour market work that is reflected in child-bearing, whereas even after such fixed effects are controlled for in the FECL model, the fact of having children of pre-school age in the household generates costs of working that are much higher than for older children, because of the cost of alternative child-care arrangements.

Local Labour Market Variable

The omission of the local rate of unemployment in the FECL model was not accepted, as it was for the pooled model. Here, at least for the probability of working high part-time hours, the rate of unemployment in the county of residence has a negative effect that is significant at the 90% confidence level. The marginal effect for this hours range is also quite large, a 1% increase in the unemployment rate decreasing the probability of choosing this hours range by nearly 3 points. This supports, at least partially, the hypothesis that local labour market conditions are important in determining the response of wives to their husbands' unemployment.

¹¹ Note that the coefficient on the dummy for the effect of children aged over 4 years on the probability of working low part-time hours reported in Table D2 is also positive and significant. However, the coefficient on this variable in the FECL model is considerably larger.

Husband's Employment Status

Finally, the expected change in the role of the husband's employment status in determining the labour supply of the wife does not occur. The significance of the effects drops in each case, but the marginal effects of the variables are very similar to those obtained in the pooled model. This result indicates that, even after accounting for the possibility that a husband being out of work indicates unfavourable labour market characteristics which his wife may share and which may, in turn, determine her labour supply, the fact of a husband's being out of work makes his wife less likely to work. In fact, 'switching on' this dummy makes her about 13 points more likely to work either full-time or low part-time hours. This result indicates a remarkable degree of complementarity of leisure times between husbands and wives.

In order to establish the robustness of this result, the variable for the husband being at work was dropped from the FECL model and the consequences examined. The results, which are not reported here, show that the coefficient on $y_i^{end(h)}$ becomes statistically significantly positive at the 99% level of confidence and that $y_i^{ex(ben)}$ shows a significant negative effect on both full-time and high part-time hours of work, as would be expected. However, the coefficient on the local rate of unemployment is left virtually unaffected, so that the possibility that the husband being in work is strongly correlated with the wife's being in work because of local labour market conditions is not supported by the data. This leaves complementarity of leisure times as the most plausible explanation for the result.

4.5.2 Testing the Importance of Accounting for Fixed Individual Effects

The results obtained from the FECL do not differ from those obtained in the pooled model for many of the variables that are common to both. Therefore it is important to test whether accounting for fixed effects are important at all as if it is not, the FECL estimates are inefficient and the results from the pooled model preferable. Since the fixed effects are not estimated in the FECL model, the hypothesis that these are the same for every individual, $\alpha = \alpha$, cannot be directly tested as a restriction. Moreover, it is not possible to use an *LR* test to compare the model with the alternative which is suitable in the case of homogeneity, the pooled model, since the FECL model is esti-

mated on a restricted set of data and the likelihoods of the two models are therefore not comparable.

Instead, the Hausman test can be used. The variance of the vector of differences between the coefficients, $(\beta_{FE} - \beta_P)$, is

$$V[\beta_{FE} - \beta_P] = V(\beta_{FE}) + V(\beta_P) - Cov(\beta_{FE}, \beta_P) - Cov(\beta_{FE}, \beta_P)'$$

Hausman (1978) established that under the null hypothesis of no systematic difference between an efficient and an inefficient estimator, here the pooled conditional logit model and the FECL model,

$$\begin{aligned} Cov[(\beta_{FE} - \beta_P), \beta_P] &= Cov(\beta_{FE}, \beta_P) - V(\beta_P) = 0 \\ \Rightarrow Cov(\beta_{FE}, \beta_P) &= V(\beta_P), \end{aligned} \quad (4.14)$$

so

$$V[\beta_{FE} - \beta_P] = V(\beta_{FE}) - V(\beta_P). \quad (4.15)$$

The relevant Wald test for the difference of the estimators is, therefore,

$$\chi_K^2 = [\beta_{FE} - \beta_P]' [V_{FE} - V_P]^{-1} [\beta_{FE} - \beta_P]. \quad (4.16)$$

This test statistic has a χ^2 distribution with K degrees of freedom, where K is the number of variables that are common to both models, β_P is the $K \times 1$ vector of common coefficient estimates from the pooled conditional logit model, β_{FE} that from the Chamberlain model, and V_P and V_{FE} are the estimated variance matrices from the two models.

Because of the differences in specification between the pooled and conditional logit models shown in Tables 4.2 and 4.3, the pooled model is re-estimated so that all the time-varying variables included in the FECL model are also included in it. This involves changing the specification of the variables that reflect the effects of children so that they are dummies rather than continuous, and adding the county unemployment rate. The result of this estimation is shown in Appendix D.

The calculated test statistic for the hypothesis of no difference in the estimators, and hence no heterogeneity, is $\chi_{17}^2 = 57.41$, while the tabulated values are $\chi_{17,0.05}^2 = 27.59$ and $\chi_{17,0.01}^2 = 33.41$, which implies firm rejection of the hypothesis of

homogeneity at all usual levels of confidence. Clearly, accounting for fixed individual effects is important.

4.6 Conclusions

This chapter has entailed the estimation of a multinomial fixed-effects conditional logit model of the labour supply of the wives of unemployed men. The results obtained show that:

- It is important to account for individual-specific heterogeneity.
- There is no evidence that the income received by a husband when unemployed that depends on the labour supply of his wife is a determinant of her labour supply decision.
- The local rate of unemployment has some small negative effect on the probability of a woman being observed working.
- The strongest determinants of the labour supply of wives of unemployed men are the presence of small children in the household, and a very strong complementarity of leisure times between husband and wife.

5. A Dynamic Model of the Labour Supply of the Wives of Unemployed Men

5.1 Introduction

In Section 4.1, it was emphasized that many of the patterns in the *LSUS* data that emerged from their inspection in Chapter 2 could be explained by persistent heterogeneity among the women surveyed. In particular, it was noted that the wives of men with longer unemployment spells had a lower level of labour market participation, even before their husbands' unemployment began; that subsequently these women had a lower level of added worker activity; and that those who did not work before their husbands' spells began had a lower level of transitions either towards or away from work. These patterns are consistent with the presence of unobserved characteristics, possibly shared with the husband, that determine the reactions of wives to their husbands' unemployment.

However, several of these features may also be accounted for by an alternative explanation, namely that the labour market state occupied by a woman at the date of her husband becoming unemployed determines her reaction to that unemployment to a significant extent. This is known as 'true' state dependence, meaning that the experience of an event changes preferences, budget constraints or prices so that choices in one period affect choices in future periods. This may arise for several reasons, including:

- If human capital depreciates whilst a woman is out of the labour force, so that the quality of women who have been out of the labour force is reduced.
- If employers use current employment as an indicator of the quality of an applicant, in terms of her attachment to the labour force.
- If preferences are endogenous, so that they are formed by habit, as discussed, for example, in Kapteyn and Woittiez (1990).

'Spurious' state dependence, on the other hand, means that previous experience appears to determine future experience solely because it is a proxy for unobservables which affect choices and which are persistent over time. Only this 'spurious' state dependence is allowed for in using the Fixed Effects Conditional Logit model (FECL) of Chapter 4 to estimate the determinants of the labour supply of women married to unemployed men. It was stressed in Section 4.2.3 that the FECL model allows for no true state dependence. In order to allow for true state dependence, a model which allows for the dynamics of labour supply must be employed.

It is the application of such a model to the *LSUS* data that is the subject of this chapter. In Section 5.2, a Markov model of labour supply is discussed, in theoretical terms in Section 5.2.1 and in terms of the modelling issues that arise in applying it to the *LSUS* data in Section 5.2.2. Section 5.3 goes on to discuss a modification of the Markov model, the Mover-Stayer model, again with the application of the model discussed in Sections 5.3.2, 5.3.3 and 5.3.4. The results of using this latter model are reported and discussed in Section 5.4. Section 5.5 concludes.

5.2 Markov Models

5.2.1 The Theory of Markov Models

Markov models are dynamic, discrete-state, discrete-time models, and are therefore appropriate for the modelling of transitions. In such models, the probability distribution of y_{it} is specified as a function of past values of itself, where $y_{it} = 1$ if individual i is in state j at time t .

The most commonly applied Markov models are first order ones; these allow only for the possibility that y_{it} depends on y_{it-1} , but not on y_{it-2} , y_{it-3} , and so on. A first order Markov model is completely characterized by the initial conditions together with the transition probabilities, which are

$$P_{i,jk,t} = \Pr[y_{it} = j | y_{it-1} = k]$$

The Markov matrix is the $J \times J$ matrix associated with each individual i in which each element is the probability of a transition between two particular states, where J is the

number of possible states. It is these probabilities that are estimated in a Markov model. If $P_{i,jk,t}$ is the same for all t , then the model is stationary; if $P_{i,jk,t}$ is the same for all i , the model is homogenous. Interestingly, Amemiya (1985) points out that if the y_{it} are independent over t , so that transitions into states are the same regardless of the original state, then the likelihood function of the Markov model is reduced to the likelihood function of a cross-section discrete-choice model. Thus, the Markov framework may be seen as generalizing cross-section models.

Where homogeneity is not assumed, the determinants of the elements of the Markov matrix may be estimated econometrically. The standard first order Markov model, with explanatory variables, for a binomial choice is:

$$P[y_{it} = 1 | y_{i,t-1}] = F(\beta x_{it} + \gamma x_{it} y_{i,t-1})$$

Then

$$P_{i,jk,t} = F(\beta x_{it})$$

and

$$P_{i,jk,t} = F((\gamma + \beta)x_{it}) \quad (5.1)$$

Thus, $y_{i,t-1}$ is included in the set of independent variables, and can be treated as exogenous, for the purposes of asymptotic results. If the process generating the y_{it} is genuinely first-order Markov, then maximum likelihood estimates of the β and γ are consistent for fixed T as $N \rightarrow \infty$ (Amemiya, 1985).

There are several advantages to using Markov models of labour supply. First, in contrast to the FECL model used in Chapter 4, information on all individuals is used in estimating the parameters. Thus, none of the questions of sample selectivity that arose in Chapter 4 arise in this case. Second, Markov models allow for state dependence of the transition probabilities. Again, this contrasts with the FECL model, as mentioned already. Thirdly, both time-varying and time-constant variables may be included in the specification of these models. Although the restriction that variables to be used in the FECL model must be genuinely time-varying does not affect the estimation of the parameters on the variables of interest, since these variables are time-varying, it may also be useful to assess the importance of some demographic variables which are constant over time, such as age, for example.

However, the importance of the first-order assumption, where used, should not be under-estimated. In a pure first order Markov model, past history affects the future

only through its influence on the state occupied at $t-1$. Thus, the past values of variables should have no effect on the current realization of the state. Often a first-order model is assumed for convenience, or because the data required to apply higher-order models are not available, rather than because economic theory really predicts first-order Markov behaviour. This is important because if it is all past experience, rather than the state occupied at $t-1$ alone that determines current behaviour, then no consistent estimator of the parameters is available, unless one of two assumptions hold.

One possibility is that the process is in equilibrium. Since it is very likely that there are long adjustment delays in implementing labour supply decisions,¹ and since in all the households surveyed, an event has taken place - the husband becoming unemployed - which makes a recent reconsideration of the optimal labour force status more likely, it is improbable that the process observed in the *LSUS* data set is in a long-run equilibrium. Unless the husband's unemployment is perfectly anticipated, it is likely to cause a reassessment of the wife's labour supply decision, because of the new information about future household income that it carries.

The alternative condition which ensures that a first order Markov model will yield consistent estimates of labour supply parameters is if the pre-sample history of the process being examined is truly exogenous. This is unlikely in any model of labour supply, since the process of making labour supply decisions begins where compulsory education ends; data over such long periods are rarely available, and certainly not in the *LSU* survey. So the assumption of an exogenous pre-sample history may not be valid here.

Because of the importance of the validity of the first order assumption for the consistency of the parameter estimates, several tests of the first order assumption have been developed. The most obvious method entails the inclusion of higher order terms in the regression equation and testing for their collective significance. However, it has been pointed out (Hsiao, 1986; Maddala, 1987) that it is not necessarily the case if higher order terms are found to be significant that this indicates true state dependence of a higher order. Rather, it may be that unobserved persistent heterogeneity is causing

¹ For example, Pudney and Thomas (1992) estimate a mean adjustment lag of 96 weeks for the wives of unemployed men.

serial correlation in the model, so that past values of the dependent variable seem to have explanatory power, whereas in fact it is the correlation between these past values and the current error term which is being captured.

A true first order binomial Markov model, without any exogenous variables is

$$y_{it}^* = \rho y_{i,t-1} + \alpha_i + e_{it} \quad (5.2)$$

where $y_{it} = 1$ if $y_{it}^* > 0$ and $y_{it} = 0$ otherwise, while a model with serial correlation and no state dependence is

$$y_{it}^* = \alpha_i + u_{it}, \quad u_{it} = \rho u_{i,t-1} + e_{it} \quad (5.3)$$

Thus, it is necessary to eliminate the possibility that any second order effects are due to serial correlation. A proper test for true higher order state dependence should therefore control for the unobserved individual-specific effects which cause serial correlation.

However, it is not enough to test for

$$\Pr(y_{it} | y_{i,t-1}, x_{it}, \alpha_i) = \Pr(y_{it} | x_{it}, \alpha_i) \quad (5.4)$$

where α_i are the individual-specific fixed effects and ℓ is the order of state dependence being tested. This is because their not being equal could be because of past y_{it} containing information on the current u_{it} . Chamberlain (1984) argues that in a serial correlation model, a change in x has its full effect immediately, whereas if there is true state dependence, the change in x has lasting effects. Thus, an appropriate test is to include lagged independent variables in a fixed effects model, but not the lagged dependent variable:

$$\Pr(y_{it} = 1 | x_{it}, x_{i,t-1}, \dots, \alpha_i) = \Pr(y_{it} = 1 | x_{it}, \alpha_i) \quad (5.5)$$

This equality holds if there is no true state dependence and is false if there is true state dependence.

If the conclusion is that there is both heterogeneity and true state dependence, there is no model in which both fixed individual effects and lagged dependent variables may be included. Chamberlain (1985) does suggest an auto-regressive fixed effects logit model, but Maddala (1987) points out that a major drawback of the model is that no exogenous variables can be used with it. Moreover, data with $T \geq 4$ are needed to estimate a model in which first order state dependence is allowed for, and with $T \geq 6$

to estimate a model with second order effects, since the sufficient statistics for the α are y_{i0} , $\sum_t y_{it}$, and y_{iT} for the first-order model and y_{i0} , y_{i1} , $\sum_t y_{it}$, y_{iT-1} and y_{iT} for the second order model; conditioning on these statistics typically involves discarding much of the data. The second order model has been used by Narendranathan and Elias (1993) to test for the effect of $y_{i,t-2}$ on current unemployment in order to justify the subsequent estimation of a first order model, while Magnac (1996) used both first and second order versions. But because exogenous variables may not be used, these models are not of interest when analysing the labour supply of the wives of unemployed men.

The estimation of a dynamic model in which individual-specific effects are specified as random is also complicated, particularly if the assumption of the exogeneity of the initial conditions is not valid. One solution, suggested by Heckman (1981) is that the initial state, y_{i0} , be modelled as a function of x_{i0} , and estimated jointly with the auto-regressive model of $P_{i,j,t}$.

For each of these proposals, the question surely arises as to what extent any attempt to account for both persistent unobserved heterogeneity and true state dependence in a panel of just three waves, as with the *LSUS* data, is likely to be over-demanding of the data. This is a point also raised by Alessie *et al.* (1992) when modelling labour market transitions based on a two-period survey.

A further, more fundamental, point should also be raised. Throughout the above discussion, the emphasis has been on the consistent estimation of the effects of economic and demographic variables on the long-run probability of occupying a particular state. This is certainly the appropriate approach for tackling many policy issues, as in the analysis of the effects of changes in the taxation system on overall participation, for example. However, it can be argued that, given that unemployment is typically a temporary phenomenon, it is the short-term effects of the social welfare system that are relevant to the labour supply of the wives of unemployed men.

Equally, for the purposes of evaluating policy changes in the treatment of income earned by the wives of the unemployed, the decomposition of state dependence into true state dependence and individual heterogeneity is not of central importance.

For these reasons, a Markov model employed in the present context is best interpreted as a reduced form model of the determinants of transitions between states, and where conditioning on the initial state carries the burden of accounting for both state dependence and all of the unobserved heterogeneity in the sample.

The inclusion of $y_{i,t-1}$ as an independent variable in a Markov model is equivalent to the separate estimation of the $P_{i,\mu,t}$ for each $y_{i,t-1}$. This can be seen from the fact that if, instead of estimating the model over all individuals, the sample is separated according to the initial state, then, in a binomial choice setting, the model is:

$$P_{i,\mu,t} = F(\beta \mathbf{x}_{it})$$

$$P_{i,j,t} = F(\gamma \mathbf{x}_{it})$$

with $\gamma \neq \beta$. This is the model used in Boskin and Nold (1975). But this is equivalent to

$$P(y_{it} = 1 | y_{i,t-1}) = F[\beta \mathbf{x}_{it} + (\gamma - \beta) \mathbf{x}_{it} y_{i,t-1}] \quad (5.6)$$

which is of the same form as the standard model defined by Equation 5.1 above.

In a multinomial context, this extends straightforwardly to

$$P_{ijk} = F(\beta \mathbf{x}_{it} + \gamma \mathbf{x}_{it} \sum_j y_{ijt} - 1) \quad (5.7)$$

for $j = 1, \dots, J$. For a given initial state, j , this can be estimated as

$$P[y_{it} = k | y_{i,t-1} = j] = F(\beta \mathbf{x}_{it}) \quad (5.8)$$

which is equivalent to re-writing Equation 5.7 as

$$P_{ijk} = F\left[(\beta - \gamma) \mathbf{x}_{it} + \gamma \mathbf{x}_{it} \sum_j y_{ijt} - 1\right] \quad (5.9)$$

5.2.2 Modelling issues

Some practical issues arise in applying a model of transitions to the *LSUS* data. Crucially, the cell sizes for some transitions are very small, and in some cases non-existent, a point which was raised in Section 2.3.2. Tables 2.4 to 2.7 show that the problematic cells for estimation purposes are, for the transitions between the key date and the first interview, $\Pr(y_{PT<10,3} | y_{FT,-1})$, $\Pr(y_{FT,3} | y_{PT<10,-1})$, $\Pr(y_{FT,3} | y_{PT>10,-1})$

$\Pr(y_{PT>10.3}|y_{PT<10,-1})$, and between the two interviews, for $\Pr(y_{PT<10.15}|y_{FT,3})$ and $\Pr(y_{FT,15}|y_{PT<10.3})$. The estimation of models of these transitions is difficult.

There are several ways to address this issue. One is to ignore the problem. Then no inference can be drawn as to the effect of some variables on the probability of being in a given state, but where standard errors are calculated, they can be taken to be accurate. However, the estimation of some models, in particular those for women working full-time at $t = -1$, and for women working part-time, less than ten hours at $t = -1$, is not possible using a standard software package; in these cases, the models do not converge.

A second option is to condition on certain destination states not being possible given a particular initial state. Thus, for example, for women working full-time initially, the destination state of low part-time hours would be excluded from the choice set, so that the constraint would be imposed that $\Pr(y_{PT<10.3}|y_{FT,-1}) = 0$. Similar constraints could be imposed for the other problematic cells detailed above.

The clear disadvantage of this approach is that it is no more true that low part-time hours is not an option for women working full-time initially than it is for women working high part-time hours initially. However, in practice, the results obtained using this approach are very similar to those obtained using the first approach of ignoring the problem of small cell sizes and estimating over all individuals in the relevant initial state, with all destination states possible.

A third possibility is to group the states at time $t - 1$ into two states - working and not working, combining full-time work and both part-time work states into one. In this way, the number of individuals over whom estimation would be carried out for women working at $t - 1$ would be large enough that standard errors could be calculated for all variables and destination states. It is useful to note that the model combining the three working states into one initial state is equivalent to the estimation of the three models separately, but restricting their coefficients to be equal. Of course, in the current situation, such restrictions may not be tested because of the numerical problems under discussion.

This latter approach has theoretical validity if it is true that the dependence of the destination state on the initial state arises not because of the number of hours a

woman worked in that initial state, but because of the fact that she worked at all at the initial date. This hypothesis is certainly not an unreasonable one; it may be true, for example, that employers regard participation *per se* as an indication of positive unmeasured characteristics and hire from the pool of participants first, or that women get utility from working that does not vary with the number of hours worked, and it is this aspect of work which generates a state dependence in their labour supply. For example, women may enjoy daily contact with their colleagues, but be indifferent between two and eight hours of daily contact with them.

The disadvantage of this approach is that it lessens the extent to which the model can be regarded as one of transitions. While the emphasis on movement between participation and non-participation is not lost, it is not possible to interpret the effect of a variable on the probability of working, say, full-time, at t conditional on working any positive hours at $t-1$ as its effect on the probability of changing state, since the state of origin may also have been full-time work.

Nonetheless, this third approach is the most suitable in a model of labour market status whose aim is to account both for heterogeneity and state dependence. It is on this concept of a Markov model, in which the importance of the job status of the previous period is based on whether that state entailed participation or not, that the model used in Section 5.4 is based.

Finally, when discussing the implications of the small cell sizes for some transitions, it should be mentioned that this feature of the *LSUS* data also makes the estimation of any second order Markov models very difficult. With sufficiently large cell sizes, it would be possible to estimate

$$P[y_{it} = j | y_{it-1}, y_{it-2}] = F(\beta x_{it} + \gamma x_{it} \sum_j y_{it-1} + \eta x_{it} \sum_j y_{it-2})$$

But with the *LSUS* data, few coefficients on the state occupied at $t-2$ can be estimated. In any case, given that it is difficult to think of a theoretical model which would predict that the states occupied in the previous two periods, but no more, would determine labour supply, the estimation of second order terms is interesting only to the extent that it controls further for heterogeneity within a group. Other explanatory variables are also available which may satisfactorily control for such heterogeneity.

5.3 Models of Mover-Stayer Behaviour

5.3.1 Description of the Mover-Stayer Model

In Section 2.3.2, the point that there was evidence of a mover-stayer pattern in the data was mentioned. The Mover-Stayer model (Blumen *et al.*, 1955; Goodman, 1961) proposes a particular form of extreme heterogeneity in the population that cannot be captured by a Markov matrix, namely that there are some individuals in the population, the stayers, who will never leave the state they occupy, so that they have a zero probability of making a transition. The remainder, the movers, make transitions according to a first order Markov chain model.

If S_j is the proportion of the sample who are stayers in state j and V_{jk} is the probability that a mover is in state k at time t given that she was in state j at time $t-1$, then the transition probabilities of an individual who has not been identified either as a stayer or a mover are

$$P_{jk} = S_j + (1 - S_j)V_{jk}$$

and

$$P_{jj} = (1 - S_j)V_{jj} \quad (5.10)$$

Goodman proposes a simple non-parametric estimator for the S_j , the proportion of the sample who make no transition throughout the sample period. Generally however, unless the observation period is long, some movers will be mistakenly identified as stayers; hence Goodman describes his estimator, \hat{S}_j , as an upper bound for the true S_j , since if any of those who do not move throughout the sample period are in fact movers rather than genuine stayers, then the true S_j are lower. Frydman (1984) confirms that \hat{S}_j is not the Maximum Likelihood Estimator (MLE) of S_j unless T is large, and develops the MLE of S_j . The calculation of Frydman's S_j is detailed in Section 5.3.3 and its application is discussed in Section 5.3.4.

5.3.2 The Application of the Mover-Stayer Model using Goodman's \hat{S}_j

Prior to addressing the issues that arise in using Goodman's estimator of S_j in the estimation of a Mover-Stayer model of transitions, it is useful first to discuss the estimation of the model when information exists that perfectly identifies movers and

stayers in the sample. The implications of the possibility that \hat{S}_j is an over-estimate of the true S_j can then be clarified and the issues that arise specifically from the use of \hat{S}_j isolated.

Two methods of estimating a Mover-Stayer model are considered here. One approach is based on the Double-Hurdle (D-H) model proposed by Cragg (1971). In D-H models, an individual must pass two hurdles before she is observed making a transition; first, she must be a mover and second, she must wish to make a transition. Modelling behaviour in this way is consistent with the hypothesis that individuals may be divided into movers and stayers, since stayers do not consider making transitions, by definition.

Examples of the application of D-H models are provided by Blundell *et al.* (1986) in their work on female labour supply, where the first hurdle to be overcome is an unemployment constraint, and by Jones (1989) in his study of cigarette consumption, where the first hurdle is a participation decision. In both of these examples, both hurdles are specified parametrically, but it is also possible to estimate the first hurdle non-parametrically, as in Micklewright *et al.* (1990), in their investigation of early school leaving, where the first hurdle is calculated using administrative school-leaving rules.

The D-H model that is relevant to the Mover-Stayer framework may be written as follows:

Observed choice: $y_{it} = j$ where $P_{ijt} > P_{ikt} \forall k \neq j$

$$P_{ijt} = S_j + (1 - S_j)V_{ijt}$$

$$P_{ikt} = (1 - S_j)V_{ikt}$$

Mover hurdle: $w_i = \alpha z_i + v_i$ i a mover if $w > 0$

i a stayer otherwise.

Choice of state j if i a mover: $u_{ij} = \beta x_{it} + e_{it}$

$$V_{ijt} = F(\beta x_{it} + e_{it}) \quad (5.11)$$

However, in this case, the 'mover hurdle' is not estimated parametrically; rather, estimates of the population S_j , such as \hat{S}_j , are used. The S_j included as the first hurdle

are, therefore, not individual-specific except to the extent that they depend on the state j occupied by the individual at $t = -1$. The likelihood function for the D-H model can therefore be written as:

$$L = \prod_j \prod_{y_t = y_{t-1}} S_j + (1 - S_j)V_{ij} \prod_{y_t \neq y_{t-1}} (1 - S_j)V_{ijk} \quad (5.12)$$

In the alternative approach to the estimation of the model, the determinants of the movers' transition matrices are estimated only over those identified as movers. Thus, data on individuals not observed to move throughout the sample period are not used. This is the estimation procedure that is usually understood by the term 'Mover-Stayer Model', following its application in this way by McCall (1971). In the case where there is no error in identifying movers and stayers, estimation in this way yields consistent results.²

It is useful to note that where the S_j are consistently estimated, the McCall and D-H approaches are equivalent, since the Cragg Double-Hurdle model described by Equation 5.11 may also be applied in a two-stage procedure, consistently estimating the first hurdle, and then, conditional on this hurdle, estimating the second hurdle (Jones, 1989, pp.25 n.1); this is precisely the procedure entailed in the McCall approach.

In practice, the S_j are not known and must be estimated; this means that the possibility of error in their estimation arises. A survey over sixteen months, such as the *LSU* survey, would not normally be regarded as having a sufficiently long time-span to identify movers and stayers accurately; $T=3$ cannot be regarded as 'large'. Admittedly, this problem is mitigated to some extent by the fact that the women in this survey are observed during a period when the household's financial situation is changing in a way that makes transitions more likely. As detailed in Section 2.3.1, the level of transitions in this population of the wives of the unemployed is higher than for all married women. Hence, it is possible to argue that the circumstances under which the *LSUS* was undertaken make the observation of movers making transitions more likely. Nonetheless, it seems likely that some movers are mis-identified as stayers using

² There are other circumstances in which the estimation of McCall's Mover-Stayer model gives consistent results; these are discussed below.

Goodman's method of calculating S_j , and it is important to consider the consequences of the over-estimation of the S_j for the consistency of the parameter estimates.

In the D-H approach to the estimation of the model, the inconsistent estimation of the first hurdle clearly implies inconsistent estimates of the determinants of the V_{ijk} . Thus, if the \hat{S}_j are incorrect, estimation of the model using the D-H approach is not appropriate. Moreover, where the \hat{S}_j are correct, it may be argued that while both the McCall and D-H models produce consistent results, the McCall version is superior in terms of efficiency, since it uses extra information that the D-H model does not use about the identity of the movers. Although the D-H model uses information on all individuals to estimate the determinants of the movers' transition matrix, the extra individuals it uses in the estimation are irrelevant, since they are, by assumption, stayers.

In order to discuss the implications of the possible over-estimation of the S_j for the consistency of the McCall approach, it is useful to write the model as follows:

$$\begin{aligned} V_{ijk} &= F(\beta x_{ik} + e_{ik}) \\ I_i &= \gamma q_i + u_i \end{aligned} \quad (5.13)$$

where I is the propensity of a mover to be identified as a mover; i is identified as a mover if $I > 0$ and as a stayer otherwise.

Recall that the McCall model entails estimation only over those identified as movers, for whom $I > 0$. Thus, the over-estimation of S_j results in the estimation of the determinants of the transitions over a smaller set of individuals than would be the case if the true S_j were known; clearly this results in inefficiency. Moreover, if the error in the identification of movers, u , is correlated with the error in the choice of destination state, e , then the problem of sample selection bias also arises. If there are unobservable factors that determine whether a true mover is observed to move or not that also determine an individual's destination state, then the estimates will be biased. This might arise if, for example, within the group of movers, women who have higher labour market motivation are most likely to make a transition quickly, and so to be included in the set of observed movers, and are also most likely to make transitions into destination states entailing higher hours of work. This may be more plausible for

women not working initially, and for whom a transition, by definition, entails a move into work.

On the other hand, it is also possible that within the group of movers, who are, by definition, more flexible in their attitude to their working hours than are stayers,³ those who are most flexible are likely to move sooner than those who are less flexible, and are therefore more likely to be observed as movers. There is no obvious reason why flexibility with regard to hours of work should be associated with a particular destination state. In this case, $\text{cov}(u,e) = 0$ and the estimation only over those with $I > 0$ is consistent.

Although it is not clear whether $\text{cov}(u,e) = 0$ or not, this assumption is maintained for the remainder of this chapter. The assumption cannot be tested formally, since the equation giving the propensity of a mover to be identified as such is not estimated parametrically. The implication of the independence assumption is that if, as seems likely, the \hat{S}_j over-estimate the true S_j , the estimates of a Mover-Stayer model using the McCall approach are inefficient but unbiased. Sections 5.3.3 and 5.3.4 attempt to improve the efficiency of the estimates obtained using \hat{S}_j .

The McCall Mover-Stayer models reported in Appendix G are of the determinants of the transitions of those asserted to be movers when \hat{S}_j is used as the estimator of the proportion of stayers in the sample. When specifying the models to be estimated, the modelling issues arising in the discussion of the application of the Markov model in Section 5.2.2 are taken into account. Hence, two sets of transitions are estimated for each of the two initial states, working and not working, for transitions between $t = -1$ and $t = 3$, and for those between $t = 3$ and $t = 15$. Thus the models estimated for those who are defined as movers are:

$$\Pr(y_{i3}|y_{i,-1} = FT \text{ or } PT > 10 \text{ or } PT < 10, i \in \hat{S}_j) = F(\beta_{x_{ij3}}) \quad (5.14)$$

$$\Pr(y_{i15}|y_{i,3} = FT \text{ or } PT > 10 \text{ or } PT < 10, i \in \hat{S}_j) = F(\beta_{x_{ij15}}) \quad (5.15)$$

$$\Pr(y_{i3}|y_{i,-1} = None, i \in \hat{S}_j) = F(\beta_{x_{ij3}}) \quad (5.16)$$

$$\Pr(y_{i15}|y_{i,3} = None, i \in \hat{S}_j) = F(\beta_{x_{ij15}}) \quad (5.17)$$

³ Such flexibility may derive from a woman having no strong culturally-determined opinion on the 'appropriate' labour market behaviour of a wife.

Of course, for stayers:

$$\Pr(y_{i3} | y_{i-1} = j, i \in \hat{S}_j) = 1 \quad (5.18)$$

$$\Pr(y_{i15} | y_{i3} = j, i \in \hat{S}_j) = 1 \quad (5.19)$$

For example, Equation 5.17 should be read to mean that the probability of occupying state j at $t = 15$ for a woman who was not working at $t = 3$, and given that she has been identified as a mover, is a function of explanatory variables x at the values they take at $t = 15$. Note that for a woman who has been identified as a mover, she does not necessarily make a transition between the two dates in question. For example, a woman who moves only between the first and second interviews will register no transition in the model of transitions between the key date and first interview, given by Equation 5.14, but is still included in the estimation sample.

The functional form used for F is the logistic one. The explanatory variables are the same as were described in Section 4.3.1, and since some of these are choice-specific, a multinomial, conditional logit framework is the appropriate one. Hence, the interpretation of the coefficients is as described in Section 4.3.2.

There are two reasons for estimating the transitions between $t = -1$ and $t = 3$ separately from those between $t = 3$ and $t = 15$, rather than pooling the destination states and modelling the destination states conditional on the initial states together, that is, rather than estimating Equations 5.14 and 5.15 together, and Equations 5.16 and 5.17 together. First, the events that occur between the key date and the first interview - the husband becoming unemployed - differ from those that occur between the two interviews - the husband returning to work, or exhausting his UB entitlement. These events can be anticipated to varying extents. While the husband's unemployment may well be entirely unexpected, the exhaustion of his UB, once unemployed, is capable of being perfectly anticipated. This means that if there is a delay in implementing decisions once taken, the parameter estimates will depend on the date of the initial date and the destination date.

Secondly, even if this were not the case, and the Markov matrix for movers were expected to be stationary, different amounts of time elapse between the two pairs of dates; four months pass between the key date and the first interview, and twelve

months between the two interviews. This automatically requires the separate estimation of these transitions.

5.3.3 The Calculation of Goodman's \hat{S}_j and Frydman's \tilde{S}_j

In calculating \hat{S}_j , as much information as possible should be used to identify movers. Thus, all transitions, including those among working states as well as those between work and non-work, are counted as valid for the identification of a mover. Moreover, rather than examining the job status of each individual only at the three principal dates to identify movers, the weekly data collected retrospectively for a year at the second interview, and examined in Section 2.4, are also used. Individuals who are in the same states at the first and second interviews, but who report having made a transition between those two dates, are therefore also included in calculating the \hat{S}_j . As mentioned in Section 2.4.2, there are 65 women who fall into this category.⁴ Note that, for these women, no transition is made either in the model of transitions between the key date and the first interview, or in that between the first and second interviews.

As pointed out in the previous section, it seems likely that, however much information is used in the calculation of \hat{S}_j , these estimates may over-state the true S_j , and Frydman (1984) proposes an alternative estimator which yields consistent estimates. The estimator proposed by Frydman is:

$$\tilde{S}_j = 1 - \frac{n_{j0} - n_j}{n_{j0}(1 - \hat{V}_{jjT})} \quad (5.20)$$

where n_{j0} is the number of individuals in state j at the beginning of the sample period, $t = 0$, n_j is the number of individuals observed in state j in all periods, and \hat{V}_{jjT} is the relevant element of the diagonal of the transition matrix according to which a mover moves between $t = 0$ and $t = T$. The quantity $(n_{j0} - n_j)$ is the observed number of individuals starting in state j and making at least one transition by time T , whilst $n_{j0}(1 - \hat{V}_{jjT})$ is the number of individuals expected to make a transition out of state j if all n_{j0} individuals are movers. Thus Frydman's estimator can be thought of as the

⁴ It was also mentioned in Section 2.4.2 that 12 of these women make only one transition, which must be a mistake. However, I considered that if a woman reported making transitions, then she was probably a 'mover', even if the nature of the transition was reported incorrectly.

proportion of expected movers observed to stay in one state throughout the sample period, rather than the proportion of the whole sample observed to stay.

Frydman suggests a recursive method for estimating the V_{jT} ,⁵ but given that data are available in the *LSUS* which might reasonably be expected to explain the pattern of transitions of movers, it seems more appropriate to use predicted probabilities from an estimation over observed movers only to calculate the V_{jT} . Assuming, as discussed in Section 5.3.2, that there is no correlation between the error in the identification of movers and the error in the choice of destination state, such an estimation will yield consistent, although not efficient estimates of the effects of variables on the probability of occupying the alternative states if everyone in the sample is a mover. Hence, the procedure used to estimate the \tilde{S}_j is as follows:

- For each state j , the determinants of the probability of occupying that state at $t = 3$ are estimated only over individuals identified as movers according to \hat{S}_j , and separately for those working at $t = -1$ and for those not working at that date; this entails estimating Equations 5.14 and 5.16.
- Using the coefficients obtained, the probability of occupying each state is predicted for all individuals.
- The state predicted to have the highest probability of being chosen is then identified as the predicted state, and those predicted to occupy a different state at $t = 3$ than that observed to have been occupied at $t = -1$ are identified as predicted movers.
- The same procedure is repeated for predicting movers between $t = 3$ and $t = 15$; Equations 5.15 and 5.17 are estimated, again using \hat{S}_j .
- The number of individuals predicted to make a transition between either pair of dates is taken as the number of individuals that would move if all individuals moved according to the transition matrix of movers, V_{jT} .
- The proportion of those in each initial state who are predicted to move during the sample period and are observed to move is then taken as the proportion of movers in that initial state; \tilde{S}_j is the difference between this quantity and one.

⁵ The method suggested assumes a stationary Markov process, which is unlikely to hold here.

Table 5.1. The elements used to calculate \hat{S}_j and \tilde{S}_j .

State	n_{j0}	$(n_j)_{ALL}^*$	$(n_{j0} - n_j)_{PRED}^\dagger$	$n_{j0}(1 - \hat{V}_{HT})$	\hat{S}_j	\tilde{S}_j
Full-Time	299	180	105	265	0.602	0.574
Part-Time, > 10 Hours	237	127	97	207	0.536	0.507
Part-Time, < 10 Hours	72	22	48	71	0.306	0.310
None	1072	884	88	374	0.825	0.738

* Excludes all transitions, including those of individuals not predicted to move.

† Includes only transitions by those predicted to move.

Table 5.1 gives the elements used in the calculation of both \hat{S}_j and \tilde{S}_j , and allows a comparison of the two estimates. The table shows small differences between \hat{S}_j and \tilde{S}_j for those working full-time or high part-time hours before their husbands became unemployed and virtually no difference for initial low-hours part-time workers. However, a notable difference does arise for women not working at $t = -1$. Nonetheless, the proportion of stayers estimated by \tilde{S}_j among the initial non-workers is still very high, at 74%.

5.3.4 The Application of the Mover-Stayer Model using Frydman's \tilde{S}_j

The incorporation of \tilde{S}_j into a Mover-Stayer framework raises no new issues if estimation is carried out according to the D-H approach detailed in Section 5.3.2. The values of \tilde{S}_j calculated in Section 5.3.3 are substituted for \hat{S}_j , with consistency of the results depending on the consistency of the \tilde{S}_j .

However, a point raised in Section 5.3.2 in comparing the D-H and McCall approaches remains valid; some individuals can be positively identified as movers by the fact that they are observed making transitions, and the use of this information on the identities of some movers improves the efficiency of the estimates.

A Double-Hurdle-based approach to estimation, using Equation 5.12 as the likelihood function, treats any individual who is in the same state at two successive dates in the same way, whether or not she moves at another point during the sample period. It seems preferable to use the fact that, for an individual who is observed to move at some stage, her probability of being a mover is one, and then to use the extra

information implied by the calculation of \tilde{S}_j to assign a probability of being a mover to those who are not observed to move.

In order to develop this point further, it is convenient to use a simplified model, entailing a two state world of participation and non-participation. Thus, a transition may be made either from work to non-work or from non-work to work. If the information that some individuals are certainly movers is to be incorporated into the model, sample separation is necessary. For those who are observed to move during the survey period, with $i \in \hat{S}_j$, the transition probabilities may be specified as follows:

$$\begin{aligned} V_{jk} &= \Pr(i \in \tilde{S}_j) F(\beta x_{ij}) = F(\beta x_{ij}) \\ V_{jj} &= \Pr(i \in \tilde{S}_j) * 1 + \Pr(i \notin \tilde{S}_j)(1 - F(\beta x_{ij})) = 1 - F(\beta x_{ij}) \end{aligned} \quad (5.21)$$

These expressions are based on the point that, for an individual who is observed to make a transition, the probability that she is not a stayer, $\Pr(i \in \tilde{S}_j)$, is one and, as a corollary to this, that the probability that she is a stayer is zero. The contribution of these individuals to the likelihood function is therefore identical to the contribution of a mover to the McCall Mover-Stayer likelihood. Note that the probabilities of making a transition and not making a transition sum to one.

For those who are not observed to move during the survey period, and so with $i \in \hat{S}_j$,

$$\begin{aligned} V_{jk} &= \Pr(i \in \tilde{S}_j) F(\beta x_{ij}) = (1 - \tilde{s}_j) F(\beta x_{ij}) \\ V_{jj} &= \Pr(i \in \tilde{S}_j) * 1 + \Pr(i \notin \tilde{S}_j)(1 - F(\beta x_{ij})) = \tilde{s}_j + (1 - \tilde{s}_j)(1 - F(\beta x_{ij})) \\ &= 1 - (1 - \tilde{s}_j) F(\beta x_{ij}) \end{aligned} \quad (5.22)$$

It is not true for an individual who does not move at any stage that the probability that she is a mover, $\Pr(i \in \tilde{S}_j)$, is one. Rather, she has positive probabilities both of being a mover and of being a stayer. The magnitudes of these probabilities, $(1 - \tilde{s}_j)$ and \tilde{s}_j , are not as in the D-H version of the model, however. $(1 - \tilde{s}_j)$ and \tilde{s}_j must be adjusted, since they express probabilities for the sample as a whole, whilst the probability of an individual who is not observed to move being a stayer must be significantly higher than for the whole sample, since the probability of being a stayer is zero for those that are observed to move.

The reasoning followed in calculating the \tilde{s}_j for those not observed to move during the sample period is shown below; the detailed calculations are included in Appendix F.

$$\begin{aligned}(1 - \tilde{s}_j) &= \Pr(\text{observed mover is a mover}) * \Pr(\text{observed to move}) \\ &\quad + \Pr(\text{observed stayer is a mover}) * \Pr(\text{observed to stay}) \\ &= 1 * (1 - \hat{s}_j) + \Pr(\text{observed stayer is a mover}) * \hat{s}_j\end{aligned}$$

$$\text{Thus, } \Pr(\text{observed stayer is a mover}) = [(1 - \hat{s}_j) - (1 - \tilde{s}_j)] / \hat{s}_j \quad (5.23)$$

It is important to note that, as in Equation 5.22, the probabilities of making and not making a transition also sum to one in Equation 5.23. However, although the probability of an individual who is not observed to move during the sample period making a transition is positive, this outcome is never observed and so is not included in the likelihood function. Since this model resembles a mixture of the McCall and D-H approaches to estimating the Mover-Stayer model, I refer to it as the mixed Mover-Stayer model. Equation 5.24 gives the likelihood function for this model.

$$L_i = \prod_j \prod_{\substack{t \in \hat{S}_j \\ y_{it} = y_{it-1}}} V_{ijt} \prod_{\substack{t \in \hat{S}_j \\ y_{it} = y_{it-1}}} V_{ijt} \prod_{\substack{t \in \hat{S}_j \\ y_{it} = y_{it-1}}} V_{ijt} \quad (5.24)$$

Again, the determinants of the destination states, j , are estimated separately for those working initially and those not working initially, for transitions between $t = -1$ and $t = 3$ and for those between $t = 3$ and $t = 15$.

5.4 Results of a Mover-Stayer Model

The results presented in this section are the estimates from the mixed Mover-Stayer models given by Equations 5.21, 5.22 and 5.24, since this is the preferred approach to applying the Mover-Stayer model. Both the McCall model and the D-H model using \tilde{s}_j are reported, for the purposes of comparison, in Appendix G. For both the mixed and D-H models, the likelihood functions were programmed in *STATA* and maximized using that package's *ml* maximization routine. These programs are included in Appendix H.

5.4.1 Results for Movers Working at $t - 1$

Here, the estimated determinants of the destination states of movers at the first and second interviews are reported for those working at $t - 1$. The destination states at the first interview for movers who worked at the key date are estimated as reported in Table 5.2, while Table 5.3 gives the results of modelling the state occupied at the second interview for movers who worked at the first interview.

A first point that should be made about the results shown in Tables 5.2 and 5.3 concerns the differences in the variables that are included in the two specifications. For some variables, these differences arise because of the nature of the variation in the variables. Thus, the husband's job status may be included for transitions between $t = 3$ and $t = 15$, since many have re-entered employment by the second interview, whereas at the first interview, all husbands are unemployed, so the variable cannot be included for transitions between $t = -1$ and $t = 3$.

Similarly, difficulties are likely to arise in the estimation of the effects of $y_i^{ex(ben)}$ and $y_i^{ex(nlv)}$ on certain transitions. In the case of the former, this difficulty comes from the fact that, although at the first interview some individuals' husbands are eligible for UB, the non-variable part of which comprises this variable, while others' are not, by the second interview almost every husband has exhausted his entitlement to UB. The only variation in this variable at $t = 15$ comes from those husbands who have exited their sampled spell and then re-entered unemployment by the second interview, and who are entitled to receive UB, making it difficult to estimate this variable's effect on transitions between $t = 3$ and $t = 15$.

On the other hand, difficulties with the precise estimation of $y_i^{ex(nlv)}$ are more likely to occur in estimating transitions between $t = -1$ and $t = 3$, since in many cases this variable is made up almost entirely of the husband's wage, which, because the husbands are unemployed at the first interview, shows little variation at that date. Thus, a well-determined effect is not expected for this variable at $t = 3$, whereas at $t = 15$, many husbands have returned to work, thus generating the required variation.

Income Variables

The significant positive coefficients on the wage variable, $y_i^{end(w)}$, in both of these models indicates that these women do respond to economic variables in making their

labour supply decisions. For transitions both between $t = -1$ and $t = 3$ and between $t = 3$ and $t = 15$, the effect of $y_{ij}^{end(w)}$ is estimated to have a quadratic relationship with utility.

For both sets of results, a £1 increase in the weekly wage in the relevant hours range increases the probability of working in that range by between 0.5 and 1.75 percentage points, while being given £1 not to work increases the probability of being observed not working by around 1 point. A £1 increase in the full-time wage is a much lower proportional increase than a £1 rise in the part-time weekly wage, but again, this is a result of the use of one choice-specific variable for the wage within a conditional logit structure, a point which was discussed in Section 4.4.

Table 5.2. Results of the mixed Mover-Stayer model of destination states at $t = 3$ for women who are movers and were working at $t = -1$. Asymptotic t -statistics in brackets.

Non-Choice-Specific Variables	Full-Time		Part-Time > 10 Hours		Part-Time < 10 Hours	
	Coefficient (t -Stat.)	Marginal Effect	Coefficient (t -Stat.)	Marginal Effect	Coefficient (t -Stat.)	Marginal Effect
$y_t^{ex(nly)}$	-0.0806 (-2.40)	-0.0227	-0.0317 (-1.01)	0.0029	-0.0878 (-2.62)	-0.0053
$\left(y_t^{ex(nly)}\right)^2$	0.0012 (2.21)	0.0003	0.0006 (1.05)	-0.0000	0.0012 (2.33)	0.0001
Dummy: Children Aged 0-4	-1.1098 (-1.53)	-0.2139	0.4587 (0.89)	0.1058	1.2335 (2.16)	0.1482
Dummy: Children Aged > 4	0.0897 (0.19)	-0.0648	0.4808 (1.25)	0.0561	1.0428 (2.38)	0.0738
Wife's Age	-0.0178 (-0.96)	-0.0131	0.0349 (2.04)	0.0123	0.0450 (2.17)	0.0045
Constant	-2.0239 (-2.16)	-	-3.4089 (-4.03)	-	-3.3314 (-3.48)	-
Choice-Specific Variables	Coefficient	t -Statistic	Marginal Effects $\times 10^2$			
			F-T	P-T>10	P-T<10	None
$y_{ij}^{end(w)}$	0.0556	3.71	1.3082	1.2414	0.5577	0.7960
$\left(y_{ij}^{end(w)}\right)^2$	-0.0002	-2.79	-0.0039	-0.0037	-0.0017	-0.0024
$y_{ij}^{end(h)}$	-0.0041	-0.31	-0.0955	-0.0906	-0.0407	-0.0581
Number of Observations: 608			Log Likelihood: -350.0			

Notes: All money amounts are in pounds. Marginal effects are calculated at the sample probability of occupying the relevant state. Here, $\Pr(FT) = 0.378$, $\Pr(PT > 10) = 0.336$ and $\Pr(PT < 10) = 0.113$.

One disconcerting point does arise for this wage result, however. That is that the quadratic effect estimated for both these regressions implies a maximum that is within the sample range, at £139 for the destination state at the first interview and at £89 for the state at the second interview, which are both within the observed range for both full-time and high-hours part-time workers, although above the average in each case. This result implies that beyond a relatively modest weekly income, utility falls with income, a result which is difficult to believe.

Table 5.3. Results of the mixed Mover-Stayer model of destination states at $t = 15$ for women who are movers and were working at $t = 3$. Asymptotic t -statistics in brackets.

Non-Choice-Specific Variables	Full-Time		Part-Time > 10 Hours		Part-Time < 10 Hours	
	Coefficient (t -Stat.)	Marginal Effect	Coefficient (t -Stat.)	Marginal Effect	Coefficient (t -Stat.)	Marginal Effect
$y_t^{ex(nly)}$	-0.0118 (-2.74)	-0.0036	-0.0074 (-2.07)	-0.0006	-0.0087 (-1.63)	-0.0001
$y_t^{ex(ben)}$	0.0823 (2.34)	0.0299	0.0255 (0.66)	-0.0031	0.0142 (0.30)	-0.0025
Wife's Age	0.4345 (2.86)	0.1108	0.3589 (2.64)	0.0427	0.5524 (2.81)	0.0227
(Wife's Age) ²	-0.0054 (-2.69)	-0.0015	-0.0040 (-2.34)	-0.0004	-0.0066 (2.67)	-0.0003
Husband at Work	2.8504 (4.05)	0.4363	1.0704 (1.89)	0.0786	0.7277 (1.02)	-0.0788
Constant	-12.4273 (-4.33)	-	-10.0664 (-3.84)	-	-12.7746 (-3.42)	-
Choice-Specific Variables	Coefficient	t -Statistic	Marginal Effects $\times 10^2$			
			F-T	P-T>10	P-T<10	None
$y_{ij}^{end(w)}$	0.0711	3.63	1.7219	1.5579	0.5709	1.0362
$(y_{ij}^{end(w)})^2$	-0.0004	-2.90	-0.0091	-0.0082	-0.0030	-0.0055
$y_{ij}^{end(h)}$	-0.0044	-0.35	-0.1072	-0.0970	-0.0356	-0.0645
Number of Observations: 559			Log Likelihood: -274.1			

Notes: All money amounts are in pounds. Marginal effects are calculated at the sample probability of occupying the relevant state. Here, $\Pr(FT) = 0.411$, $\Pr(PT > 10) = 0.324$ and $\Pr(PT < 10) = 0.088$.

The results for $y_{ij}^{end(w)}$ clearly show a statistically significant effect of economic variables on the labour supply decision of those women who were working at the relevant $t-1$. In contrast, $y_{ij}^{end(h)}$, which is the variable of primary interest in these models, is completely insignificant at both the first and second interviews, indicating

that these women do not take the benefit income that their husbands receive into account when making their labour supply decisions.

There are several reasons why this result might hold. First, there may not be pooling of income in these households, a point which is discussed further below. Secondly, the wife's beliefs as to the likely duration of her husband's unemployment may counteract her evaluation of the effect of means testing on her optimal labour supply decision. However, the inclusion in the model of the destination state at $t = 3$ of a dummy variable for whether the husband leaves his sampled unemployment spell by $t = 15$, which might capture the expected duration of the husband's unemployment, is firmly rejected by an LR test, which casts some doubt on the validity of this second explanation.

In both Table 5.2 and Table 5.3, $y_t^{ex(aly)}$, the part of household income that is exogenous to the wife's labour supply, but not received as unemployment payments by the husband, has a negative effect on the labour supply of the wife, which is significant in every case except for the probability of choosing high part-time hours at $t = 3$. As pointed out above, a well-determined effect is not expected for this variable at $t = 3$, since most husbands are unemployed and not earning a wage, whereas its significance in the model of Table 5.3 is not surprising. The other sources of income included in this variable, such as interest payments, child benefit and FIS, must be driving this result. This is in itself surprising, as these elements would not be expected to change significantly over time, so conditioning on the initial state might be expected to account for the effect of this variable.

A further surprising result is the retention of $y_t^{ex(ben)}$ in the model of Table 5.3, but not in that of Table 5.2. As noted above, the only variation in this variable at $t = 15$ is from husbands who have exited their sampled unemployment spell, and then re-entered unemployment, but are still entitled to UB. In Section 4.4, the point was made that $y_t^{ex(ben)}$ can be expected to have a positive effect on the probability of participation in the labour market to the extent that this variable picks up similarities in characteristics between UB-receiving husbands and their wives, and a negative effect to the extent that the variable is regarded as non-labour income by a wife. The positive effect on the probability of working full-time here indicates that it is capturing similar

characteristics between husbands and wives; it does not reflect the fact of the husband's unemployment, since this is accounted for by a dummy for his work status.

Demographic Variables

The age variable estimates from Table 5.2 indicate that the older a woman is, the more likely she is to be in part-time work at $t = 3$, given that she worked at $t = -1$; the result for the effect on the probability of working full-time is insignificant. For the destination state at $t = 15$, the results show a positive effect of age on the probability of working either full-time or part-time as opposed to not working. The relationship is quadratic, with age reducing the probability of working full-time beyond the age of 40, and beyond 45 and 42 for high and low part-time hours respectively. Overall, the effect of age is to encourage working women to stay in work; perhaps as women get older, habit plays a greater role in the labour supply decisions of women, up to a certain point.

The most surprising results given in these models, however, are those for the variables for the presence of children of different ages in the household. Here, both pre-school and school-aged children are important to labour supply at the first interview, but not at the second interview. But more unexpected are the signs on the coefficients and marginal effects for these variables. They show that, at $t = 3$, younger children have a negative, but insignificant effect on the probability of working full-time, a completely insignificant effect on the probability of working high part-time hours, and a significant *positive* effect on the probability of working low part-time hours. Older children have no effect on the probability of working full-time or part-time, more than ten hours, but again have a positive effect on the probability of working part-time, less than ten hours per week. At $t = 15$, children have *no* effect on any of the hours choices

Moreover, the marginal effects of these dummies for the presence of children are large, where positive. For example, the presence of a younger child in the household increases the probability of a woman working part-time, less than ten hours per week at $t = 3$ by nearly 15 points over the probability that she would have of working in this hours range if there were no young child in the household.

It is not possible that this result arises only because of the fact that all these women are already working, and thus are likely to have child-minding arrangements already in place when taking the decision modelled. This fact would explain insignificant results for the presence of children, but not significant positive effects. Moreover, these positive coefficients for low hours of work also arise for women who do not work initially, as discussed in Section 5.4.2 below.

The pattern of the results across the different hours ranges, whereby the effects are increasingly positive as the number of hours worked decreases, suggests that there is a positive effect of children of the probability of participation for these women that is counteracting the usual negative effect, which typically decreases with the number of hours worked in any case. One possibility is that the positive effect of children on the probability of working is due to an 'income' effect caused by the higher needs of households with children. If, when a husband becomes unemployed, these needs are not matched by the definition of needs used in the calculation of the entitlement to SB, then a woman may be *more* inclined to work if she has children. This positive effect may be counteracted by the usual negative effect of children on the probability of working, which would explain why there tend to be negative effects of children for high hours ranges. In this case, the unimportance of children to the destination state at $t = 15$ should be interpreted as the result of the positive and negative effects counteracting each other for all hours ranges.

However, for the above explanation to be valid, there must be a plausible reason why a positive income effect would manifest itself in a dynamic model of labour supply, but not in a static one, or, alternatively, why the negative effect of children would not be strong enough to counteract the always-present income effect of children as usual. For those working initially, the likelihood of having child-care arrangements already established, thus reducing the search costs element of the fixed costs of working implied by children can be used as an explanation. The discussion of the results for those not working initially is postponed until these results are presented in Section 5.4.2.

Husband's Work Status

The final variable that requires comment is the husband's employment status variable, which is included in the specification of the destination state at $t = 15$. The results show that the husband being at work has a positive effect on the probability of the wife working in any of the three hours ranges, although the result is only clearly statistically significant for full-time work, and marginally significant for high part-time hours. The marginal effect of this variable on the likelihood of working full-time is also particularly large, with a 43 point increase in the probability of the average woman being observed in this hours range when this dummy is 'switched on'. This result may indicate either complementarity of leisure times between husband and wife, or personal characteristics common to both husband and wife that make it more likely that both of them work.

Other Variables

Finally, it is worth commenting on the variables that are absent from the specifications shown in Tables 5.2 and 5.3. First, the inclusion of many of the variables that may be included to control for heterogeneity was rejected by *LR* tests. I refer here to variables such as the number of times the husband had been unemployed in the five years prior to the first interview, or whether the husband exited his sampled unemployment spell by the second interview. This suggests that conditioning on the state occupied by a woman at $t-1$, and on her being a mover, provides adequate control for heterogeneity.

Further, it should be noted that the local rate of unemployment is not included in these specifications. This is plausible for two reasons: firstly, because women who are already working can choose to remain in the same job, although it might be expected that the unemployment rate would increase the probability of working if it encourages inertia because of fear of being unable to find another job should the household's situation change again; but secondly, because areas of high unemployment tend to have persistently high unemployment, and only changes in the rate of unemployment would be expected to affect the probability of a woman's participation in the labour market.

5.4.2 Results for Movers Not Working at $t - 1$

In this section, the results of the mixed Mover-Stayer model for those *not* working at each of the two initial dates are reported and discussed. Table 5.4 gives the estimated results for the destination states chosen at $t = 3$ by women who are movers, but who did not work at $t = -1$, while Table 5.5 reports the estimated determinants of the labour force status at $t = 15$ of movers who were not working at $t = 3$.

Table 5.4. Results of the mixed Mover-Stayer model of destination states at $t = 3$ for women who are movers and were not working at $t = -1$. Asymptotic t -statistics in brackets.

Non-Choice-Specific Variables	Full-Time		Part-Time > 10 Hours		Part-Time < 10 Hours	
	Coefficient (t -Stat.)	Marginal Effect	Coefficient (t -Stat.)	Marginal Effect	Coefficient (t -Stat.)	Marginal Effect
$y_t^{ex(ben)}$	-0.0394 (-1.45)	-0.0004	-0.0368 (-1.95)	-0.0008	0.0126 (0.46)	0.0002
Wife's Age	-0.1172 (-2.66)	-0.0013	-0.0497 (-1.96)	-0.0011	-0.0555 (-1.67)	-0.0006
Constant	-0.9187 (-0.59)	—	-1.5968 (-1.55)	—	-2.1098 (-1.79)	—
Choice-Specific Variables	Coefficient	t -Statistic	Marginal Effects $\times 10^2$			
			F-T	P-T>10	P-T<10	None
$y_{ij}^{end(w)}$	0.1071	3.48	0.1165	0.2303	0.1269	0.4698
$\left(y_{ij}^{end(w)}\right)^2$	-0.0005	-2.39	-0.0006	-0.0011	-0.0006	-0.0022
$y_{ij}^{end(h)}$	0.0556	2.78	0.0605	0.1196	0.0659	0.2440
Number of Observations: 1072			Log Likelihood: -165.3			

Notes: All money amounts are in pounds. Marginal effects are calculated at the sample probability of occupying the relevant state. Here, $\Pr(FT) = 0.011$, $\Pr(PT > 10) = 0.022$ and $\Pr(PT < 10) = 0.012$.

Income Variables

The results shown in Table 5.4 indicate a strong importance of economic variables for the labour supply decision at $t = 3$ of women who were not working at $t = -1$. Turning first to the results for $y_{ij}^{end(w)}$, the wage variable, the relationship with utility is shown to be quadratic, with a positive effect of wage income on utility, but only up to a weekly income of £107 per week. Beyond this point, the effect is negative, again, well within the sample range of weekly wages. The coefficient size is also notable; it is larger than that found for either of the models reported in the previous section for women working at $t - 1$. The marginal effects indicate that a £1 increase in the weekly

wage would increase the probability of working of the average woman by between 0.1 and 0.25 percentage points, and, if she received a £1 payment for not working she would be about 2 points more likely to be observed not working.

The most striking result of Table 5.4, however, is that $y_i^{end(h)}$ has a positive and statistically significant effect on utility, a result that has not been found previously in this study. As to the size of its effect, it is smaller than that for the wage variable, although the fact that the latter is included as a quadratic makes direct comparison difficult. However, the results indicate that a £16 increase in the means-tested benefit income that a man would receive if his wife worked full-time would be necessary to increase his wife's probability of working in that hours range by 1 percentage point, with a similar rise necessary to increase her probability of working in the low part-time hours range, and a raise of about £8 being sufficient to raise her probability of working part-time more than ten hours per week by 1 point. An increase of £4 in the benefit income which the household would receive if she did not work would increase her probability of not working from 95% to 96%.

It must, of course, be taken into account that many of those not working initially do not react at all to this or any other variable when making their labour supply decisions, by assumption, because they are stayers. Thus, if, for example, the earnings disregard of SB were increased from £4 per week to £8 per week, then amongst movers, the probability of choosing not to work would decrease from 95% to 94%. But since movers comprise just 26% of those not working at the key date according to \tilde{S}_j , the effect on participation of the wives of the unemployed would be to increase it by about 0.25%.

It is interesting to note that this result does not change significantly when stayers are included in the estimation sample, however. When the model is estimated over all women who were not working at $t = -1$, the results are very similar to those reported in Table 5.4, both in terms of coefficient size and statistical significance.

Turning to the other income variable that is included, $y_i^{ex(ben)}$, it is found to have a negative effect on both the probability of working full-time and that of working high part-time hours, although the effect for the former hours range is not significant at usual levels of confidence. The negative marginal effects of this variable on the

probability of working in these hours ranges are of a similar order to the positive effects of an increase in means-tested benefit income on these probabilities. These women appear to be much more sensitive to unemployment payments, whether endogenous or exogenous to their labour supply, than women who were working before their husbands became unemployed.

A possible reason for this is that pooling is more complete in households where a woman does not work outside the home, of necessity. Thus, if her husband becomes unemployed, the unemployment payments which he receives have a greater effect on her utility than if she were working.

However, unlike women who worked at $t = -1$, the women here, who were not working at that date do not appear to take $y_i^{ex(nh)}$ into account when making their labour supply decisions, although it should be pointed out that since there is little variation in the value of $y_i^{ex(nh)}$ at $t = 3$ because of the fact that all husbands are registered as unemployed at that date, it is the emergence of this variable as statistically significant for women working at $t = -1$ that is noteworthy rather than its non-significance in the case of women not working initially.

Turning to the results for income variables for women who were not working at $t = 3$, the impression gained from Table 5.4 that women not working initially might be more sensitive to the functioning of the benefit system than their working counterparts is reversed. The wage variable, $y_g^{end(w)}$, is statistically significant and positive, but smaller than that found for the destination state at $t = 3$ of women who were not working at $t = -1$. Moreover, the means-tested benefit income variable, $y_g^{end(h)}$, is once again insignificant, and $y_i^{ex(nh)}$ does not emerge as important either.

One important point should be made about this particular model. In this case, when this model is estimated over all women not working at $t = 3$, without accounting for the possibility that some individuals may be stayers, the wage effect is significant and *negative*, a result that contradicts a fundamental tenet of economic theory. It was, in fact, this result which motivated the adoption of the Mover-Stayer framework used here. The fact that this result changes completely when the possible presence of stayers is allowed for indicates that heterogeneity within the group of women not working at $t = 3$ is severe. However, as mentioned above, for the estimation of the destination

state occupied at $t = 3$ by those not working at $t = -1$, accounting for stayers makes little difference to the estimates. It is also significant that this difference according to whether stayers are allowed for or not arises for women who were not working initially, as in Section 2.3.2, attention was drawn to the greater tendency of women working before their husbands' unemployment began to be movers.

Table 5.5. Results of the mixed Mover-Stayer model of destination states at $t = 15$ for women who are movers and were not working at $t = 3$. Asymptotic t -statistics in brackets.

Non-Choice-Specific Variables	Full-Time		Part-Time > 10 Hours		Part-Time < 10 Hours	
	Coefficient (t -Stat.)	Marginal Effect	Coefficient (t -Stat.)	Marginal Effect	Coefficient (t -Stat.)	Marginal Effect
Number Children Aged 0-4	-1.5512 (-3.37)	-0.0512	-0.3006 (-0.88)	-0.0143	0.4884 (1.65)	0.0183
Number Children Aged > 4	-0.2541 (-1.20)	-0.0098	0.4658 (2.74)	0.0247	0.4934 (2.66)	0.0157
Wife's Age	-0.0275 (-1.31)	-0.0010	0.0385 (1.71)	0.0021	0.0095 (0.37)	0.0003
Husband at Work	1.7673 (2.79)	0.0798	2.9289 (5.93)	0.3331	1.9202 (4.63)	0.0956
Constant	-1.7675 (-1.54)	-	-5.0575 (4.28)	-	-3.8271 (-3.28)	-
Choice-Specific Variables	Coefficient	t -Statistic	Marginal Effects $\times 10^2$			
			F-T	P-T>10	P-T<10	None
$y_{ij}^{end(w)}$	0.0184	2.01	0.0586	0.0938	0.0586	0.1939
$y_{ij}^{end(h)}$	-0.0063	-0.48	-0.0200	-0.0321	-0.0200	-0.0663
No. Observations: 1154			Log Likelihood: -320.0			

Notes: All money amounts are in pounds. Marginal effects are calculated at the sample probability of occupying the relevant state. Here, $\Pr(FT) = 0.033$, $\Pr(PT > 10) = 0.054$ and $\Pr(PT < 10) = 0.033$.

Finally, it is useful to point out that when the model of transitions between the key date and the *second* interview is estimated, thereby modelling the choice at $t = 15$ of those who were not working before their husbands' unemployment spells began, $y_{ij}^{end(h)}$ does not emerge as significant. Thus, not only is the significant effect of means-tested benefit income limited to movers who did not work before their husbands' unemployment spells began, it also appears to be a short-term effect.

Demographic Variables

I turn now to the results for the variables representing children in these two models. First, no variables for either the presence of or the number of children of different ages

in the household were retained in the model of the destination state at $t = 3$. For the model of Table 5.5, on the other hand, both younger and older children were found to be important to labour supply, with the same pattern as described above for transitions by women who did work at $t = -1$ of increasingly positive coefficients for decreasing hours of work. There it was suggested that a positive income effect of children might be outweighing the usual negative effects of children on labour supply. For women who worked initially, having child-care arrangements already in place might be sufficient to suppress the usual negative effect of children, but for women not working initially, a different mechanism must be relevant. It may be that cross-section models find that women with children work less not because children actually have a negative effect on labour supply, but because they proxy an absence from the labour force which makes it more difficult to enter or re-enter the labour force, because of true state dependence.

In the model of the state occupied at $t = 3$ by women who were not working before their husbands' sampled unemployment spells began, age has a negative effect on the probability of working any positive hours. The older a woman is, the less likely she is to work full-time or high part-time hours at the first interview, given that she is a mover who was not working at the key date; the same is also true for low part-time hours, although this effect is only marginally significant. Taken together, this means that an older woman is least likely to enter the labour force immediately after her husband becomes unemployed. For the destination state at the date of the second interview, however, there is a marginally positive effect of age on the probability of working high part-time hours.

Husband's Work Status

One of the more interesting results given in these two tables is that for the work status of the husband. For women not working initially, this effect is positive for all three destination states involving positive hours of work. Unlike the case of initial workers, however, the coefficients are significant for all three working states. In this case, the coefficient is particularly large for its effect on the probability of working high part-time hours. The fact that the results are so much better determined in this case seem to indicate that for women working initially, the complementarity between their leisure times and their husbands' is less strong. This may be because of the endogeneity of

tastes referred to in Section 5.1, whereby habit may mean that women who work at $t - 1$ become accustomed to spending less time with their husbands.

5.5 Conclusions

In this chapter, a mixed Mover-Stayer model was chosen as the appropriate vehicle for controlling for both true state dependence of destination states, and unobserved heterogeneity of the sample. Thus, the labour market states occupied by the wife at the two dates subsequent to the husband becoming unemployed, given that she was either working or not working at the previous date, are modelled for movers only. Stayers have a zero probability of making a transition. It was estimated that:

- Of those not working before their husbands' unemployment began, 74% are stayers, with corresponding figures for the proportion of stayers of 57%, 51% and 31% among those working full-time, high part-time and low part-time hours at the key date.

The results obtained for women working initially who are movers are:

- There is no evidence that these women take their husband's benefit income into account when deciding on their optimal labour market states.
- The presence of children causes these women to be more likely to work, due to an income effect of their husbands' unemployment.
- Complementarity of leisure times emerges as an important determinant of a woman's labour supply.

For women not working initially, the results are similar, with the exception that:

- These women are less likely to work a given number of hours the lower their husbands' means tested benefits when they work that number of hours. However, this effect is a short-term one, determining transitions only in the period immediately after a husband's unemployment begins. Moreover, because it applies only to movers, who are a small proportion of those working initially, the aggregate effect of the means testing of benefits is small.

6. Conclusions

This chapter attempts to provide an overview of the conclusions drawn in this thesis. To this end, Section 6.1 gives an assessment of the contribution that this thesis makes to the understanding of the labour supply of the wives of unemployed men. In order to put these results in context, Section 6.2 recalls the explanations that were suggested as candidates in accounting for the absence in aggregate data of an added worker effect in Section 1.1, and details the support found in the thesis for each of these explanations. Where there are contradictions within the thesis, the likely sources of the inconsistencies are identified. Finally, as is customary, Section 6.3 makes some recommendations regarding the direction any future research on the question of the labour supply of women married to unemployed men should take, with particular consideration of the format a survey used to examine the issue might take.

6.1 The Contribution of this Thesis to the Understanding of the Labour Supply of the Wives of Unemployed Men

This thesis contributes to the understanding of the labour supply of the wives of unemployed men in several ways, detailed below.

Data

I use a data source that has not been used before to analyse the issues involved. The *LSU* survey is unusually rich for the purposes at hand, both in terms of sample size and information collected; this makes it surprising that this is the first attempt to exploit it to investigate the labour market behaviour of the wives of unemployed men.

Variable Specification

The variables used to test the effects of the means testing of benefits have been specified very carefully. The advantages of these specifications over those used in other studies are outlined below.

- Household income is specified for each of four different hours of work of the wife. Given that the disincentives to work part-time are expected to be stronger than the disincentives to work full-time, a point supported by the analysis of household incomes under means testing regimes in Chapter 3, the modelling of the participation decision as one determined by the income at the participation margin, when the wife works zero hours, is likely to yield misleading results. This was the approach taken in, for example, Kell and Wright (1990) and Garcia (1991).
- Throughout the thesis, a distinction is drawn between the income that a woman receives that is endogenous to her labour supply, and that which her husband receives. This allows for the possibility that women get different utility from income that they themselves earn than from that which is received by their husbands, either due to the absence of income pooling, because they feel less entitled to spend income received by their husbands, or because they do not perceive the true effect of their hours of work on means-tested benefits.
- Housing Benefit entitlements are included as means tested income. This is important given the evidence discussed in Chapter 3 regarding the severe discontinuities introduced by HB. This benefit is not included in specifying means-tested income in the Garcia (1991) paper.

Methodology

The econometric models used in Chapters 4 and 5 of the thesis are well suited to the examination of the issues of interest, and have not previously been applied to the labour supply of the wives of unemployed men. The important and novel features of the models used are indicated below.

- In Chapter 4, the multinomial version of the Fixed Effects Conditional Logit model was applied to the data. The use of the binomial FECL model has become increasingly common in recent years, but there are few examples of the use of the multinomial version, and none for the topic addressed here. The fact that this model is not commonly applied is reflected in its non-availability in any of the popular statistical software packages, which meant that it was necessary to program the likelihood function and maximize it using an appropriate routine. Thus, the use of the multinomial FECL is in itself a novelty.

- In Chapter 5, the Mover-Stayer model is used. Although several studies, including for example, Giannelli and Micklewright (1995) and Lundberg (1985) use Markov models of the labour market transitions of married women to infer the reaction of women to their husbands' unemployment, accounting for heterogeneity by allowing for the possibility that there are stayers in the sample has not been done before for the labour supply of the wives of unemployed men.
- In the application of the Mover-Stayer model, the estimation of the proportion of stayers in the sample, using a method based on a proposal by Frydman (1984), rather than making an assumption about its value, allows the efficiency of the model to be improved; again, this extension of the Mover-Stayer model has not been attempted previously.

Results

The results of the analysis of the *LSUS* data extend the existing understanding of how a woman's labour market behaviour is affected by her husband's unemployment, as follows:

- Strong evidence is found, in the descriptive analysis of the transitions data of Chapter 2, of differences in the patterns of transitions between different types of wives. The reality that these wives have a lower participation rate prior to their husbands' unemployment is well established, as detailed in Table 1.1, but to this fact, evidence is added on the variation in pre-unemployment participation rates of women according to their husbands' duration of unemployment and their benefit entitlements.
- The disincentives to work generated, in theory, by the British benefit system are well-known, and described in detail in, for example, Dilnot and Kell (1989). By examining household income carefully, as in Chapter 3, information on the extent of these disincentives in practice can be added. This analysis showed that although, as in theory, the disincentives to work appear to be stronger for part-time than full-time workers, the differences are not very large among the women in the *LSU* survey. Moreover, the differences between households entitled to SB and UB are not as strong as might be expected; this is because both the receipt of HB and the joint receipt of UB and SB blur the distinctions that arise in theory.

- Strong evidence emerges suggesting that means-tested benefits are not important determinants of the labour supply of the wives of unemployed men. Only for women not working before their husbands' unemployment began does it appear that the amount of means-tested benefit income is a determinant of their behaviour, and even then, the effect appears to be a short-run one.

6.2 Explanations of the Level of Labour Supply of the Wives of Unemployed Men

6.2.1 Local Labour Market Conditions and the Discouraged Worker Effect

As outlined in Section 1.1, a high rate of local unemployment may explain the negative correlation between the unemployment of husbands and the rate of employment of their wives if the same shock to the labour market that caused a man's unemployment reduces the probability of his wife finding a job if she decides to seek one. In this case, any added worker effect (AWE) is suppressed. Alternatively, a high rate of local unemployment may reduce participation by discouraging women from entering the labour market.

Given the lack of data on whether individual women are seeking work in the *LSUS* survey, the possible importance of local labour market conditions is accounted for by including a measure of the local rate of unemployment as a control variable in the econometric analyses of Chapters 4 and 5; thus, no distinction can be drawn between demand-side and discouraged worker effects of unemployment.

The results obtained are not entirely conclusive. In the fixed effects model of Chapter 4, whose results are shown in Table 4.3, there is a marginally significant negative effect of the local unemployment rate on the probability of a woman working high part-time hours, with a large marginal effect, a one point increase in the local unemployment rate decreasing the probability of working in this hours range by nearly 3 points. For other hours of work possibilities, however, the coefficients are statistically insignificant.

When the Mover-Stayer model is applied to the data, the results show that both for women not working initially and for those working initially, the inclusion of the

local unemployment rate is rejected in every case. This result is surprising, as it might be expected that a model that allows for different effects according to the initial state occupied would be better able to capture the importance of local unemployment to a wife's labour market state than the static FECL model, since it seems reasonable that the effect of unemployment on the probability of a woman's starting to work would be negative, whilst the effect on the probability of a woman's continuing to work would be positive, discouraging her from giving up a job for any reason that might be temporary, such as her husband's unemployment.

Overall, the evidence of the importance of the local unemployment rate is weak, and it seems that this is not a major factor determining the labour supply of the wives of the unemployed. However, two points suggest that this conclusion can be drawn only tentatively. First, to the extent that high unemployment tends to persist in given areas, the controls for heterogeneity in the sample may account for the discouraged worker effect of locally high unemployment. And secondly, it should be noted that the control used for local unemployment here is the county unemployment rate; the travel-to-work area unemployment rate would be preferable, but was unavailable.

6.2.2 Similar Characteristics of Husbands and Wives

In many ways, the *LSUS* data are not well-suited to allowing for the possibility that characteristics common to both partners in a marriage determine their labour supply. In particular, information on neither the education level nor the race of the spouses was collected, so that variables that are usually classified as observables are unobserved, rendering accounting for unobserved heterogeneity in the women especially important, and at the same time making any distinction between the importance of characteristics that are usually observable impossible. Despite the absence of some variables which are usually available, however, the panel nature of the survey allows unobserved heterogeneity to be accounted for, whether by the use of the FECL model of Chapter 4 or of the Mover-Stayer model of Chapter 5.

The relevance of similar characteristics cannot be measured directly, but can be inferred in several ways from the thesis. First, the results of the tabulations included in Section 2.3.3, showing the transitions made by women according to whether their

husbands had left their sampled unemployment spells by the date of the second interview or not, indicate that women whose husbands have longer spells are less likely to be added workers after their husbands become unemployed, and are less likely to have been working before their husbands became unemployed. Because it is likely that men who exit sooner have favourable labour market characteristics, this indicates a correlation between the labour market characteristics of individuals.

On the other hand, when this variable is included in the econometric specifications of Chapter 5 as a dummy equal to one if the husband exited his unemployment spell, it is not retained in any model. This is probably because the account that is taken of unobserved heterogeneity in using a Mover-Stayer model already controls for the importance of such proxy variables. Nor are other observable variables which might be expected to proxy characteristics of the husband which may be shared by his wife significant in any of the models accounting for heterogeneity. Significantly, however, the number of spells of unemployment the husband has had in the previous five years has a significant negative effect on the probability of working full-time or high part-time hours in the pooled conditional logit model, reported in Table 4.2, which does not control for unobserved heterogeneity.

More formally, the importance of unobserved characteristics can be judged by the comparison of the pooled conditional logit model reported in Table 4.2 and the FECL model of Table 4.3; the formal test of the difference between the results from these two models, the Hausman test outlined in Section 4.5.2, indicates that accounting for heterogeneity is important, the hypothesis of homogeneity being firmly rejected.

Hence, while unobservables' importance cannot be quantified, the approaches used in the thesis allow me to infer that this is indeed an important factor in explaining the low level of labour supply of women married to unemployed men. This result is not surprising given the fact that variables such as education and race can be accounted for only as unobservables. To go further and demonstrate clearly that it is *similarities* in these unobservables between husband and wife that drive the absence of an AWE in the wives of unemployed men is not possible here.

6.2.3 Complementarity of Leisure Times of Husbands and Wives

In testing for the importance of the complementarity of leisure times, it is necessary to control for the financial effects of unemployment; thus, in Chapters 4 and 5, carefully specified variables for the income of the household given the husband's employment situation are included. Moreover, because a correlation between the employment status of husbands and wives can also emerge due to their having similar labour market characteristics, it is important to account for heterogeneity; this is achieved by using models which control for heterogeneity in Chapters 4 and 5, applying the FECL and Mover-Stayer models respectively.

The results obtained show a remarkably consistent, large, positive effect of a husband's unemployment on the probability of his wife working. For the FECL model of Chapter 4, the effect of a husband's being employed is to increase his wife's probability of working either full-time or low part-time hours by 13 points.

For the Mover-Stayer model, Table 5.3 shows a similar pattern in the coefficients on the husband's job status for movers who were working at the first interview,¹ the husband's working increasing the probability of his wife's working full-time by 44 points, and of her working high part-time hours by 7 points. However, the statistical significance of the variable in this model is lower than in the FECL model; while the coefficient for full-time work is significant, that for high part-time hours is significant at the 10% level but not at the 5% level, and that for low hours part-time work not at all.

Interestingly, for women who are movers, but not working at the first interview, the results of the Mover-Stayer model show that the coefficients for all three hours choices are significant. For these women, the largest positive effect is on high part-time hours of work rather than full-time work. These results, with higher levels of statistical significance in all hours ranges for those not working at the first interview than for women working at that date, offer some support for the possibility that the correlation between the employment status of husbands and wives is due to the

¹ Recall that this variable cannot be included for transitions between the key date and the first interview, as all husbands are unemployed at the latter date, so there is no variation in the husband's job status.

unwillingness of wives to take on the bread-winning role of the husband when he becomes unemployed, rather than because of a desire to spend as much time together as possible. This suggests that the complementarity of leisure times found in every model applied in this thesis is specific to the wives of unemployed men, and to the situation in which these women find themselves. Thus, similar results should not necessarily be expected in models of the labour supply of all women.

6.2.4 Inertia and Adjustment Delays

Although neither the implications of women's expectations of the duration of their husbands' unemployment, nor of the time taken to implement decisions to change employment status are incorporated in a structural model that addresses them directly, some evidence on the importance of these dynamic issues may be inferred from the analysis in this thesis.

With reference to the importance of adjustment delays, it is noted in Section 2.3.1 that the average monthly rate of transition in the *LSUS* data between $t = -1$ and $t = 3$ is greater than that between $t = 3$ and $t = 15$; the monthly rate of entry to the labour market is 1% between $t = 3$ and $t = 15$, and slightly higher between $t = -1$ and $t = 3$, while for exit, the monthly rates are 1.5% between $t = 3$ and $t = 15$, and 4.3% between $t = -1$ and $t = 3$. These statistics indicate that much of the reaction to women's husbands becoming unemployed occurs in the period immediately following the start of the unemployment spell, suggesting that for many individuals, desired adjustments are achieved within three months of the change in the household situation.

As to the effect of the husband's unemployment spell being expected to be short on the wife's response to his unemployment, this is accounted for in the Mover-Stayer models estimated for the state at the first interview by including in the specifications a dummy variable for whether the husband exits his sampled spell by the date of the second interview. If the expectations of wives as to the duration of their husbands' unemployment spells are rational, then when used as an explanatory variable for the state occupied by the wives at the date of the first interview, when all husbands are still unemployed, this variable reflects the expected duration of an unemployment spell, albeit in very approximate terms. This variable may also be interpreted as a proxy for characteristics of the husband which are shared by the wife; for those working

initially, the two effects would reinforce each other, whereas for those not working at a given $t - 1$, this variable would be expected to have two opposing effects. Thus, it is important to account for unobserved heterogeneity amongst the wives in order to allow the 'expected duration' effect to emerge. This is achieved in the use of a Mover-Stayer model by conditioning both on the initial state and on being a mover. This variable cannot be used in the FECL model as it is not time-varying.

If the expectation of the duration of the husband's unemployment is important, the dummy for the husband having exited his spell by the second interview is expected to have a positive effect on the probability of working women continuing to work, and a negative effect on the probability of non-working women beginning to work. In fact, the variable has no effect on either transition type. Thus, there is no evidence that the eventual duration of the unemployment spell is related to the wife's labour supply decision.

However, it must be borne in mind that the variable used to capture this effect is crude, being a dummy, and relying on the assumption that women are all correct in their assessments of how long their husbands can be expected to be out of work, or at least that if they are wrong, as is possible given the point mentioned in Section 2.2.3 that the rate of long term unemployment increased dramatically in the years in which the survey was conducted, they are all wrong to the same extent. It seems conceivable that individuals differ in the degree of optimism about an event such as a husband becoming unemployed.

Note, however, that the use of a Markov model, in which the state occupied may depend on the state occupied in the previous period also accounts for adjustment delays to the extent that such delays differ according to the state initially occupied. The importance of state dependence can be assessed by comparing the specifications and results of the models estimated for those working initially and for those not working initially. Given the differences described in Sections 5.4.1 and 5.4.2, it is clear that there is state dependence, which may be caused by adjustment delays that are specific to the state occupied initially.

6.2.5 Unemployment Insurance and the Added Worker Effect

The results obtained in Chapters 4 and 5 indicate only patchy evidence of women taking the income received by their husbands that is exogenous to their labour supply into consideration. The variables that are relevant to the presence of an AWE in these chapters are $y_i^{ex(ben)}$, exogenous UB income, and $y_i^{ex(nly)}$, other exogenous household income, which includes the husband's wage income, if any. In the FECL model, there is no effect of $y_i^{ex(ben)}$ found, whereas $y_i^{ex(nly)}$ is found to have a significant negative effect on the probability of working in all three positive hours ranges, albeit with small effects, of less than a tenth of a percentage point.

For the Mover-Stayer model, the results differ according to the initial state conditioned on. For women working initially, the results, shown in Tables 5.2 and 5.3, are similar to those obtained using the FECL model in that they show a negative effect of $y_i^{ex(nly)}$. For transitions between $t = -1$ and $t = 3$, however, the marginal effect of $y_i^{ex(nly)}$ on the probability of being observed in full-time work is over two points, and 0.5 points for low part-time hours, which are large effects compared to other models, and to the results typically found for British women; the negative effect of non-labour income on the probability of working at $t = 15$ for women working at $t = 3$ is, as is more usual, small, at up to one third of a percentage point. $y_i^{ex(ben)}$ has a positive effect on the probability of working full-time at this date, reflecting positive unobserved heterogeneity rather than an income effect.

For movers who are non-workers initially, on the other hand, the results of the Mover-Stayer model reported in Tables 5.4 and 5.5 show no effect of $y_i^{ex(nly)}$ either for the destination state at $t = 3$ or for that at $t = 15$, but do indicate a negative effect of $y_i^{ex(ben)}$ on the probability of working either full-time or high part-time hours at $t = 3$, although the coefficient on the probability of working full-time is not significant at conventional confidence levels. $y_i^{ex(ben)}$ is found to have no effect on the probability of working at $t = 15$.

Thus, the results show that in every model, the husband's income, whether from working, or UB, or both, is a determinant of the wife's labour supply behaviour, except in determining the labour supply at $t = 15$ of women not working at $t = 3$.

6.2.6 The Means Testing of Unemployment Payments

Chapter 3 deals extensively with the nature of the disincentives generated by the means testing of UB, SB and HB in Britain in 1983-84. In Section 3.5, median effective average tax rates of between 58% and 90%, depending on the point in time and the number of hours of work concerned, are illustrated. The examples of specific households given in Section 3.4 illustrate the functioning of the benefit system clearly.

Despite the clear disincentives to work that exist, Section 3.6, which analyses the relationship between women's attitudes to working while their husbands are unemployed and the relevant effective tax rate, shows only tentative evidence that women's attitudes to the benefits of working while their husbands are unemployed are determined by the financial implications of the means testing of benefits. Although, as shown in Table 3.11, it is true that those believing their working not to be worthwhile tend to be more highly taxed by the means testing of benefits than those who believe their working to be worthwhile financially, the median tax rate affecting this latter group is nonetheless calculated to be between 57% and 70% of net wage income, which is very high.

This impression that the disincentive effect of means testing has little importance in determining the labour supply of the wives of unemployed men is confirmed to a large extent by the econometric analyses of Chapters 4 and 5. The fixed effects model of Chapter 4 finds that the potential benefit income that is endogenous to the wife's labour supply has no effect on the wife's labour supply decision. Similar results are found for women working initially when the Mover-Stayer model is applied in Chapter 5, both for $t = 3$ and $t = 15$. The exception to the rule arises for the state occupied at the first interview by women who are movers and were not working before their husbands' unemployment began. Here, the benefit income which a husband receives is an important determinant of his wife's labour supply, with a coefficient about half the size of that on the weekly wage variable in that particular model, and of a similar size to that found for the wage variables in the other models estimated. Thus, the econometric analysis indicates that the effect of means testing on benefits is to make women not working initially and who are movers less likely to start working immediately after their husbands become unemployed, the greater is the tax imposed by

means testing. Since movers comprise just 26% of all women not working at the key date, and hence just 17% of all wives in the *LSUS* sample, this effect is small.

The policy implications of these results are clear: the recent increase in the extent to which households headed by unemployed men are means tested, owing to the reduction of the UB entitlement period from a year to six months, will not decrease the participation of the wives of unemployed men in the labour market further. The sources of the differences in participation rates lie elsewhere.

6.3 The Direction of Future Research

Recommendations for future research may be made both in terms of the data required to improve on the analysis contained here, and in terms of the behaviour that should be focused on.

Data

Although the *LSU* survey is richer than most surveys available to investigate the labour supply of the women married to unemployed men, there were limitations imposed by it that could be avoided in collecting data for future research. These are addressed here.

- Some data were not included in the survey that would be neither expensive nor sensitive to collect, and whose absence created difficulties at some points in the thesis. I refer here to information on education and race. A more general point that can be made is that household surveys that focus on unemployed individuals should ideally collect as much information as possible on characteristics that may be shared by spouses, and that are relevant to their labour force participation.
- It is a drawback of the *LSUS* that information on just three points in time are available, although this survey strategy clearly has enormous advantages over a single cross-section. Whilst the Mover-Stayer model is useful in accounting for heterogeneity at the same time as true state dependence, albeit it in a rather *ad hoc* manner, it is probably not the most efficient way of dealing with these important issues. Had data for four or more points in time been collected, both fixed individual-specific effects and dynamics could be accounted for in one model, as indicated in Magnac (1996).

Intra-Household Allocation of Income

One of the most interesting points raised by this thesis is the limited extent to which the neo-classical assumption that households may be treated as a single entity is supported. It would be interesting and useful to investigate how income within the household is allocated, and whether this allocation mechanism changes in times of a husband's unemployment.

Complementarity of Leisure Times

The result that a complementarity of leisure times between husbands and wives dominates the reactions of women to their husbands' unemployment is a strong one. It would be interesting to explore whether this complementarity arises only in times of the unemployment of the 'primary earner', or holds more generally. In other words, it seems possible that there is an asymmetry in the complementarity of leisure times at the point of participation, so that whilst complementarity holds where a husband is not working, leisure times are substitutable if he works beyond a certain number of hours. This possibility seems worthy of investigation.

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Appendix A Details of British Tax, National Insurance and Benefit Rules, 1983-84

A1. Tax System Rules

- The Single Person's Allowance was £1,785 in 1983-84 and £2,005 in 1984-85.
- Tax rates for the relevant financial years were as follows:

Table A1. Tax rates for 1983-84 and 1984-85.

Tax Rate	Tax Rate Applies to Annual Taxable Income Between (£)	
	1983-1984	1984-1985
30%	0 - 14,600	0 - 15,400
40%	14,601 - 17,200	15,401 - 18,200
45%	17,201 - 21,800	18,201 - 23,100
50%	21,801 - 28,900	23,101 - 30,600
55%	28,901 - 36,000	30,601 - 38,100
60%	36,001 -	38,100 -

A2. National Insurance System Rules

- In both 1983-84 and 1984-85, the Class 1 contribution rate was 9% for contracted-in employees.
- The annual lower earnings limit, below which no contributions were paid, was £1,689.96 in 1983-84 and £1,767.96 in 1984-85.
- The annual upper earnings limit above which no further contributions were paid was £12,219.96 in 1983-84 and £12,999.96 in 1984-85.

A3. Unemployment Benefit Rules

The basic rates of UB payment were:

Table A2. Weekly basic UB for 1983-84 and 1984-85.

Year	Rate of UB Entitlement of Husband		
	Full Rate	Three-Quarter Rate	Half Rate
1983-84	£25.00	£18.75	£12.50
1984-84	£26.90	£20.29	£13.53

- The allowances for a dependant wife, who is defined to be one who does not earn more than the amount of the dependant's allowance, were:

Table A3. Weekly UB dependant's allowances for 1983-84 and 1984-85.

Year	Rate of UB Entitlement of Husband		
	Full Rate	Three-Quarter Rate	Half Rate
1983-84	£15.45	£11.59	£7.73
1984-84	£16.70	£12.53	£8.35

- The UB allowance for each dependant child was 30p in 1983-84 and 15p in 1984-85. It was abolished in the following year.

A4. Supplementary Benefit Rules

- Needs were defined according to:

Table A4. Amounts of weekly 'needs' for SB purposes.

Family Component	1983-84	1984-85
Couple	£41.70	£43.50
Child Aged Under 10 Years	£8.75	£9.15
Child Aged 11-15 Years	£13.15	£13.70
Dependant Child Aged 16-17	£15.80	£16.50
Dependant Child Aged 18	£20.55	£20.55

- Heating allowances, added to needs if there was someone in the household aged under 4 years, or over 70 years, were £1.90 in 1983-84 and £2.05 in 1984-85.

- An allowance for home maintenance was paid if the head of household owned his own home. This amount was £1.70 in both years.

A5. Standard Housing Benefit Rules

- Needs were defined according to:

Table A5. Amounts of weekly 'needs' for HB purposes.

Family Component	1983-84	1984-85
Couple	£61.00	£63.50
Each Dependant Child	£11.40	£12.90

- The 'starting figure' for standard HB was 60% of rent and rates paid. Deductions from the 'starting figure' for non-dependants were:

Table A6. Amounts of deductions from the HB 'starting figure' for non-dependants.

Age of Non-Dependant	1983-84		1984-85	
	Rent	Rates	Rent	Rates
18-20 Years	£3.95	£1.60	£6.15	£2.05
21 Years - Pensionable Age	£4.70	£1.85	£6.15	£2.05
Over Pensionable Age	£2.20	£0.90	£2.20	£0.90

- The rules for the calculation of the amount of HB payable were:

Table A7. Taper rules for HB.

Taper Rule	1983-84		1984-85	
	Rent	Rates	Rent	Rates
If Needs > Resources, Add % of Difference to 'Starting Figure'	25%	8%	25%	8%
If Needs < Resources, Subtract % of Difference from 'Starting Figure'	21%	7%	26%	9%

Appendix B Individual Likelihood Contributions for Fixed-Effects Models

Section 4.2.2 includes the individual likelihood contributions for two types of FECL models. The first of these is the simplest case, the two period, binomial choice model with no choice-specific variables. The second is the model used in Chapter 4, the multi-period, multinomial choice model with choice-specific variables. For completeness, this appendix gives a further two cases

B1. The Individual Likelihood Contribution in the Two Period, Binomial Choice FECL Model with Choice-Specific Variables

If the variables are choice-specific, then the choice in each period is a conditional logit one; substituting this means that $\Pr[(a,b)|s_{1a}=1, s_{1b}=1]$ should be expressed as:

$$\begin{aligned}
 & \frac{\left[\frac{\exp(\beta x_{1a} + \alpha)}{\exp(\beta x_{1a} + \alpha) + \exp(\beta x_{1b} + \alpha)} \cdot \frac{\exp(\beta x_{2b} + \alpha)}{\exp(\beta x_{2a} + \alpha) + \exp(\beta x_{2b} + \alpha)} \right]}{\left[\frac{[\exp(\beta x_{1a} + \alpha) \cdot \exp(\beta x_{2b} + \alpha)] + [\exp(\beta x_{1b} + \alpha) \cdot \exp(\beta x_{2a} + \alpha)]}{[\exp(\beta x_{1a} + \alpha) + \exp(\beta x_{1b} + \alpha)] \cdot [\exp(\beta x_{2a} + \alpha) + \exp(\beta x_{2b} + \alpha)]} \right]} \\
 &= \frac{\exp(\beta x_{1a} + \alpha) \cdot \exp(\beta x_{2b} + \alpha)}{[\exp(\beta x_{1a} + \alpha) \cdot \exp(\beta x_{2b} + \alpha)] + [\exp(\beta x_{1b} + \alpha) \cdot \exp(\beta x_{2a} + \alpha)]} \\
 &= \frac{\exp[\beta(x_{1a} + x_{2b}) + 2\alpha]}{\exp[\beta(x_{1a} + x_{2b}) + 2\alpha] + \exp[\beta(x_{1b} + x_{2a}) + 2\alpha]} \\
 &= \frac{1}{1 + \exp[\beta(x_{1b} + x_{2a}) + 2\alpha - \beta(x_{1a} + x_{2b}) - 2\alpha]} \\
 &= \frac{1}{1 + \exp[\beta[(x_{2a} - x_{2b}) - (x_{1a} - x_{1b})]]}
 \end{aligned}$$

B2. The Individual Likelihood Contribution in the Multi-Period, Multinomial Choice FECL Model with No Choice-Specific Variables

With three time periods, $t = 1, 2, 3$ and three states, $j = a, b, c$, for a sequence of (a, b, b) , $w_{11a} = 1$, $w_{11b} = 0$, $w_{11c} = 0$, $w_{12a} = 0$, $w_{12b} = 1$, $w_{12c} = 0$, $w_{13a} = 0$, $w_{13b} = 1$, $w_{13c} = 0$ and $s_{1a} = 1$, $s_{1b} = 2$, $s_{1c} = 0$. So

$$\Pr[(a, b, b) | s_{1a} = 1, s_{1b} = 2, s_{1c} = 0] = \Pr[(a, b, b) | (a, b, b) \text{ or } (b, a, b) \text{ or } (b, b, a)]$$

$$= \frac{\Pr[w_{11a} = 1] \cdot \Pr[w_{12b} = 1] \cdot \Pr[w_{13b} = 1]}{\left[\Pr[w_{11a} = 1] \cdot \Pr[w_{12b} = 1] \cdot \Pr[w_{13b} = 1] + \Pr[w_{11b} = 1] \cdot \Pr[w_{12a} = 1] \cdot \Pr[w_{13b} = 1] + \Pr[w_{11b} = 1] \cdot \Pr[w_{12b} = 1] \cdot \Pr[w_{13a} = 1] \right]}$$

If the variables are not choice specific, so that the choice at each date is modelled as a multinomial logit one, then this expression becomes:

$$\begin{aligned} &= \frac{\left[\frac{\exp(\beta_a x_1 + \alpha) \cdot \exp(\beta_b x_2 + \alpha) \cdot \exp(\beta_b x_3 + \alpha)}{[\exp(\beta_a x_1 + \alpha) + \exp(\beta_b x_1 + \alpha) + \exp(\beta_c x_1 + \alpha)] \cdot [\exp(\beta_a x_2 + \alpha) + \exp(\beta_b x_2 + \alpha) + \exp(\beta_c x_2 + \alpha)] \cdot [\exp(\beta_a x_3 + \alpha) + \exp(\beta_b x_3 + \alpha) + \exp(\beta_c x_3 + \alpha)]} \right]}{\left[\frac{\exp(\beta_a x_1 + \alpha) \cdot \exp(\beta_b x_2 + \alpha) \cdot \exp(\beta_b x_3 + \alpha)}{[\exp(\beta_a x_1 + \alpha) + \exp(\beta_b x_1 + \alpha) + \exp(\beta_c x_1 + \alpha)] \cdot [\exp(\beta_a x_2 + \alpha) + \exp(\beta_b x_2 + \alpha) + \exp(\beta_c x_2 + \alpha)]} + \frac{\exp(\beta_b x_1 + \alpha) \cdot \exp(\beta_a x_2 + \alpha) \cdot \exp(\beta_a x_3 + \alpha)}{[\exp(\beta_a x_1 + \alpha) + \exp(\beta_b x_1 + \alpha) + \exp(\beta_c x_1 + \alpha)] \cdot [\exp(\beta_a x_2 + \alpha) + \exp(\beta_b x_2 + \alpha) + \exp(\beta_c x_2 + \alpha)]} + \frac{\exp(\beta_b x_1 + \alpha) \cdot \exp(\beta_b x_2 + \alpha) \cdot \exp(\beta_a x_3 + \alpha)}{[\exp(\beta_a x_1 + \alpha) + \exp(\beta_b x_1 + \alpha) + \exp(\beta_c x_1 + \alpha)] \cdot [\exp(\beta_a x_2 + \alpha) + \exp(\beta_b x_2 + \alpha) + \exp(\beta_c x_2 + \alpha)]} \right]} \\ &= \frac{\exp(\beta_a x_1 + \beta_b x_2 + \beta_b x_3 + 3\alpha)}{[\exp(\beta_a x_1 + \beta_b x_2 + \beta_b x_3 + 3\alpha) + \exp(\beta_b x_1 + \beta_a x_2 + \beta_b x_3 + 3\alpha) + \exp(\beta_b x_1 + \beta_b x_2 + \beta_a x_3 + 3\alpha)]} \\ &= \frac{\exp[\beta_a x_1 + \beta_b (x_2 + x_3)]}{\exp[\beta_a x_1 + \beta_b (x_2 + x_3)] + \exp[\beta_a x_2 + \beta_b (x_1 + x_3)] + \exp[\beta_a x_3 + \beta_b (x_1 + x_2)]} \end{aligned}$$

Similarly,

$$\Pr[(b,a,b)|(a,b,b) \text{ or } (b,a,b) \text{ or } (b,b,a)] =$$

$$\frac{\exp[\beta_a x_2 + \beta_b(x_1 + x_3)]}{\exp[\beta_a x_1 + \beta_b(x_2 + x_3)] + \exp[\beta_a x_2 + \beta_b(x_1 + x_3)] + \exp[\beta_a x_3 + \beta_b(x_1 + x_2)]}$$

and

$$\Pr[(b,b,a)|(a,b,b) \text{ or } (b,a,b) \text{ or } (b,b,a)] =$$

$$\frac{\exp[\beta_a x_3 + \beta_b(x_1 + x_2)]}{\exp[\beta_a x_1 + \beta_b(x_2 + x_3)] + \exp[\beta_a x_2 + \beta_b(x_1 + x_3)] + \exp[\beta_a x_3 + \beta_b(x_1 + x_2)]}$$

and so on.

Appendix C STATA Program for Multinomial Fixed-Effects Conditional Logit Model

The data set used in the estimation of the model is as follows:

- The individual identifier is '*newcase*'. Each *newcase* has 12 observations, one for each state and each date.
- I constructed a variable '*alt*' for each individual, with values running from 1 to 96, according to the choice sequence observed. Values of *alt* from 1 to 36 represent sequences with two states the same in the choice sequence, for example (a,b,b) . Values between 37 and 60 give sequences with three different states over the survey period, for example (a,b,c) . Values from 61 to 96 are for sequences with a state missing at one of the three dates.
- I constructed 6 variables, *d1* to *d6* to represent the elements of *D*, the alternative choice sequences with the same *sy* as that actually observed. In each case, *d1* is one for the state actually observed at a date, and zero otherwise, so *d1* is the actual choice sequence. For individuals with a state missing at one of the dates (*alt* = 61 to *alt* = 96), there is only one element of *D* apart from *d1*, so *d3* to *d6* are missing. For individuals with the same state at two of the dates (*alt* = 1 to *alt* = 36), there are two elements of *D* apart from *d1*. Individuals with three different states (*alt* = 37 to *alt* = 60) have 5 alternative choice sequences.

C1. Maximum Likelihood Program

The following program, 'domaxcl' maximizes the likelihood specified in Section C2, 'myclt3j4', using the variables included in 'varlist', of which there must be at least one, with no constant. In this case, the starting values are a given by a vector of zeroes.

```
program define domaxcl
version 4.0
```

```

local varlist "req ex min(1)"
parse ""*""
tempname b
eq eqn: d1 `varlist'
ml begin
ml function myclt3j4
ml method deriv0
ml model `b' = eqn, nocons
ml sample mysamp `varlist'
tempname lf V
ml max `lf `V'
ml post fecl
ml mlout fecl
end

```

C2. Program Specifying the Individual Contribution to the Likelihood

The following program specifies the likelihood function for each individual.

```

program define myclt3j4
version 4.0
local b ""1""
local f ""2""
tempvar nomin denomin z1 z2 x1 x2 x3 x4 x5 x6 rr div rr2
#delimit ;
sort newcase date state ;
matrix score double `z1'=`b' ;
qui by newcase: gen double `z2'=sum($S_mlwgt*cond(d1,`z1',0)) ;
qui by newcase: gen double `nomin'=exp(`z2'[_N])) if $S_mlwgt ;
qui by newcase: gen double `x1'=(sum($S_mlwgt*cond(d1,`z1',0))) ;
qui by newcase: gen double `x2'=(sum($S_mlwgt*cond(d2,`z1',0))) ;
qui by newcase: gen double `x3'=(sum($S_mlwgt*cond(d3,`z1',0))) ;
qui by newcase: gen double `x4'=(sum($S_mlwgt*cond(d4,`z1',0))) ;

```

```

qui by newcase: gen double `x5'=(sum($S_mlwgt*cond(d5,`z1',0))) ;
qui by newcase: gen double `x6'=(sum($S_mlwgt*cond(d6,`z1',0))) ;
qui by newcase: gen double `denomin'=( $S_mlwgt*exp(`x1'[_N])) +
($S_mlwgt*exp(`x2'[_N])) ;
qui by newcase: replace `denomin' = `denomin' + ($S_mlwgt*exp(`x3'[_N])) if
alt<=60 ;
qui by newcase: replace `denomin'=`denomin' + ($S_mlwgt*(exp(`x4'[_N]))) +
($S_mlwgt*(exp(`x5'[_N]))) + ($S_mlwgt*(exp(`x6'[_N]))) if alt>=37 &
alt<=60 ;
qui gen double `div'=(`nomin')/(`denomin') if $S_mlwgt ;
qui by newcase: gen double `rr'=$S_mlwgt*cond(_n==_N,ln(`div'),0) ;
qui gen double `rr2'=sum(`rr') ;
scalar `f'=`rr2'[_N] ;
#delimit cr
end

```


Appendix D Pooled Conditional Logit Model Used for the Hausman Test of Section 4.5.2

The pooled conditional logit model which is used for testing the hypothesis of individual homogeneity in Section 4.5.2 is shown in Table D1.

Table D1. Results for a pooled conditional logit model that is comparable with the FECL model of Table 4.3. Asymptotic *t*-statistics in brackets.

Non-Choice-Specific Variables	Full-Time		Part-Time > 10 Hours		Part-Time < 10 Hours	
	Coefficient	<i>t</i> -Statistic	Coefficient	<i>t</i> -Statistic	Coefficient	<i>t</i> -Statistic
$y_i^{ex(ben)}$	0.0076	1.60	0.0173	3.79	0.0195	2.75
$y_i^{ex(nly)}$	-0.0106	-7.12	-0.0044	-3.94	-0.0009	-0.72
Wife's Age	0.2630	7.70	0.2955	7.71	0.1215	2.12
(Wife's Age) ² ÷ 100	-0.3722	-8.37	-0.3388	-7.17	-0.1471	-2.12
Dummy: Children Aged 0-4	-2.3174	-16.01	-1.1719	-8.42	-0.6416	-3.55
Number Children Aged > 4	-1.3029	-11.60	-0.0718	0.69	0.3504	2.13
Husband at Work	1.5321	9.24	1.1905	7.98	0.8764	4.28
Local Rate of Unemployment	-0.0140	-1.05	-0.0079	-0.61	-0.0071	-0.35
Husband's Bad Unemp. History	-0.0649	-2.44	-0.0572	-2.15	0.0073	0.203
Constant	-5.9726	9.15	-8.2959	-10.83	-5.5524	-5.23
Choice-Specific Variables	Coefficient		<i>t</i> -Statistic			
$y_{ij}^{end(w)}$	0.0287		13.81			
$y_{ij}^{end(h)}$	0.0021		0.71			
No. Observations: 5111		Pseudo-R ² : 0.394		Log Likelihood: -4244.4		

The variables included are all those that are included in the FECL model of Table 4.3, in addition to other variables reflecting individual heterogeneity that are either found to be insignificant when fixed effects are accounted for, such as $y_i^{ex(ben)}$, or

that are not time-varying and therefore cannot be included in the FECL model, such as age and the husband's unemployment history.

Appendix E Calculation of the Probability that an Observed Stayer is a True Stayer

In the mixed Mover-Stayer model of Section 5.3.4, the probability that an individual who is observed to stay in the same state throughout the sample period is a true stayer may be calculated from the information contained in \tilde{S}_j . This appendix provides the details of the calculation of these probabilities, \tilde{s}_j . Equation 5.22 notes that

$$(1 - \tilde{s}_j) = \Pr(\text{observed stayer is a mover}) = [(1 - \hat{S}_j) - (1 - \tilde{S}_j)] / \hat{S}_j$$

and this is the basis of the calculations shown below.

Stayers in Full-Time Work:

$$\tilde{S}_{FT} = 0.574 \Rightarrow (1 - \tilde{S}_{FT}) = 0.426; \hat{S}_{FT} = 0.602 \Rightarrow (1 - \hat{S}_{FT}) = 0.398$$

$$(1 - \tilde{s}_{FT}) = \frac{0.426 - 0.398}{0.602} = 0.047 \Rightarrow \tilde{s}_{FT} = 0.953$$

which means that the probability that a woman who is observed to stay in full-time work throughout the sample period is, in fact, a mover is less than 5%.

Stayers in High Hours Part-Time Work:

$$\tilde{S}_{PT > 10} = 0.507 \Rightarrow (1 - \tilde{S}_{PT > 10}) = 0.493; \hat{S}_{PT > 10} = 0.536 \Rightarrow (1 - \hat{S}_{PT > 10}) = 0.464$$

$$(1 - \tilde{s}_{PT > 10}) = \frac{0.493 - 0.464}{0.536} = 0.054 \Rightarrow \tilde{s}_{PT > 10} = 0.946$$

Stayers in Low Hours Part-Time Work:

$$\tilde{S}_{PT < 10} = 0.310 \Rightarrow (1 - \tilde{S}_{PT < 10}) = 0.690; \hat{S}_{PT < 10} = 0.306 \Rightarrow (1 - \hat{S}_{PT < 10}) = 0.694$$

$$(1 - \tilde{s}_{PT < 10}) = 0 \Rightarrow \tilde{s}_{PT < 10} = 1$$

Stayers out of Work:

$$\tilde{S}_{NONE} = 0.738 \Rightarrow (1 - \tilde{S}_{NONE}) = 0.262; \hat{S}_{NONE} = 0.825 \Rightarrow (1 - \hat{S}_{NONE}) = 0.175$$

$$(1 - \tilde{s}_{NONE}) = \frac{0.262 - 0.175}{0.825} = 0.105 \Rightarrow \tilde{s}_{NONE} = 0.895$$

Appendix F Results of McCall Mover-Stayer Model and Double-Hurdle Model with \tilde{S}_j

This appendix gives the results of the McCall Mover-Stayer model and the D-H Mover-Stayer model using Frydman's \tilde{S}_j ; these are the two models discussed in Section 5.3 as alternatives to the mixed Mover-Stayer model presented in Section 5.4.

Table F1. Results of the McCall and Double-Hurdle Mover-Stayer models of destination states at $t = 3$ for women who were working at $t = -1$. Asymptotic t -statistics in brackets.

Non-Choice-Specific Variables	McCall Model			Double-Hurdle Model		
	Full-Time	Part-Time > 10 Hours	Part-Time < 10 Hours	Full-Time	Part-Time > 10 Hours	Part-Time < 10 Hours
	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)
$y_t^{ex(nly)}$	-0.0798 (-2.40)	-0.1310 (-1.00)	-0.0878 (-2.64)	-0.0604 (-1.36)	-0.0479 (-1.33)	-0.0717 (-1.74)
$(y_t^{ex(nly)})^2$	0.0012 (2.23)	0.0005 (1.05)	0.0012 (2.35)	0.0006 (1.08)	0.0005 (0.99)	0.0007 (1.29)
Dummy: Child Aged 0-4	-1.0767 (-1.49)	0.4493 (0.88)	1.2311 (2.16)	-2.6104 (-2.25)	0.4789 (0.65)	1.2041 (1.02)
Dummy: Child Aged > 4	0.1133 (0.24)	0.4518 (1.18)	1.0395 (2.38)	-1.9705 (-1.67)	1.2098 (2.36)	1.6379 (2.52)
Wife's Age	-0.0171 (-0.92)	0.0339 (1.98)	0.0449 (2.17)	-0.0674 (-2.19)	0.0587 (2.49)	0.0813 (2.25)
Constant	-2.0470 (-2.19)	-3.3471 (-3.96)	-3.3099 (-3.46)	-1.7933 (-1.35)	-5.8183 (-4.77)	-6.2693 (-3.56)
Choice-Specific Variables	Coefficient (t-Statistic)		Coefficient (t-Statistic)		Coefficient (t-Statistic)	
$y_{ij}^{end(w)}$	0.0542 (3.61)		0.1007 (4.37)		0.1007 (4.37)	
$(y_{ij}^{end(w)})^2$	-0.0002 (-2.72)		-0.0003 (-2.99)		-0.0003 (-2.99)	
$y_{ij}^{end(h)}$	-0.0043 (-0.33)		0.0106 (0.57)		0.0106 (0.57)	
No. Observations	279		608		608	
Log Likelihood	-339.15		-441.77		-441.77	

Table F2. Results of the McCall and Double-Hurdle Mover-Stayer models of destination states at $t = 15$ for women who were working at $t = 3$. Asymptotic t -statistics in brackets.

Non-Choice-Specific Variables	McCall Model			Double-Hurdle Model		
	Full-Time	Part-Time > 10 Hours	Part-Time < 10 Hours	Full-Time	Part-Time > 10 Hours	Part-Time < 10 Hours
	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)
$y_t^{ex(nly)}$	-0.0096 (-2.34)	-0.0071 (-1.98)	-0.0088 (-1.64)	-0.0141 (-2.82)	-0.0087 (-2.21)	-0.0079 (-1.46)
$y_t^{ex(ben)}$	0.0845 (2.37)	0.0243 (0.63)	0.0015 (0.32)	0.0853 (2.33)	0.0381 (1.02)	0.0172 (0.36)
Wife's Age	0.4922 (3.03)	0.3318 (2.45)	0.5444 (2.75)	0.3266 (2.07)	0.3751 (2.69)	0.6268 (3.00)
(Wife's Age) ²	-0.0060 (-2.85)	-0.0037 (-2.17)	-0.0065 (-2.62)	-0.0042 (-2.01)	-0.0043 (-2.43)	-0.0077 (-2.94)
Husband at Work	2.5346 (3.58)	1.0225 (1.79)	0.7436 (1.04)	2.7817 (3.64)	1.0842 (1.79)	0.4763 (0.66)
Constant	-13.7186 (-4.45)	-9.5546 (-3.67)	-12.6677 (-3.37)	-9.3135 (-3.15)	-9.4664 (-3.55)	-13.4077 (-3.35)
Choice-Specific Variables	Coefficient		(t -Statistic)	Coefficient		(t -Statistic)
$y_{ij}^{end(w)}$	0.0742		(3.63)	0.0621		(3.21)
$\left(y_{ij}^{end(w)}\right)^2$	-0.0004		(-3.06)	-0.0003		(-2.40)
$y_{ij}^{end(h)}$	-0.0053		(-0.41)	0.0017		(0.13)
No. Observations	225			559		
Log Likelihood	-255.09			-497.05		

Table F3. Results of the McCall and Double-Hurdle Mover-Stayer models of destination states at $t = 3$ for women who were not working at $t = -1$. Asymptotic t -statistics in brackets.

Non-Choice-Specific Variables	McCall Model			Double-Hurdle Model		
	Full-Time	Part-Time > 10 Hours	Part-Time < 10 Hours	Full-Time	Part-Time > 10 Hours	Part-Time < 10 Hours
	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)
$y_t^{ex(ben)}$	-0.0424 (-1.55)	-0.0406 (-2.11)	0.0094 (0.34)	-0.0325 (-1.16)	-0.0302 (-1.57)	0.0193 (0.70)
Wife's Age	-0.1207 (-2.60)	-0.0479 (-1.75)	-0.0576 (-1.62)	-0.1177 (-2.71)	-0.0491 (-2.03)	-0.0542 (-1.71)
Constant	-0.4187 (-0.26)	-1.2794 (-1.19)	-1.6413 (-1.32)	-0.9434 (-0.58)	-1.6139 (-1.50)	-2.2471 (-1.99)
Choice-Specific Variables	Coefficient		(t -Statistic)	Coefficient		(t -Statistic)
$y_{ij}^{end(w)}$	0.1159		(3.59)	0.1017		(3.01)
$\left(y_{ij}^{end(w)}\right)^2$	-0.0006		(-2.51)	-0.0004		(-2.13)
$y_{ij}^{end(h)}$	0.0556		(2.73)	0.0615		(2.64)
No. Observations	188			1072		
Log Likelihood	-144.14			-237.24		

Table F4. Results of the McCall and Double-Hurdle Mover-Stayer models of destination states at $t = 15$ for women who were not working at $t = 3$. Asymptotic t -statistics in brackets.

Non-Choice-Specific Variables	McCall Model			Double-Hurdle Model		
	Full-Time	Part-Time > 10 Hours	Part-Time < 10 Hours	Full-Time	Part-Time > 10 Hours	Part-Time < 10 Hours
	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)	Coefficient (t -Statistic)
No. Children Aged 0-4	-1.2383 (-2.63)	0.0422 (0.11)	0.9274 (2.60)	-1.707 (-3.06)	-0.5819 (-1.61)	0.2054 (0.68)
No. Children Aged > 4	-0.1311 (-0.59)	0.6091 (3.34)	0.6549 (3.32)	-0.2609 (-1.09)	0.3471 (1.95)	0.3533 (1.95)
Wife's Age	-0.0236 (-1.09)	0.0430 (1.83)	0.0113 (0.40)	-0.0444 (-1.80)	0.0203 (0.85)	-0.0108 (-0.42)
Husband at Work	1.7530 (2.74)	2.8133 (5.56)	1.5371 (3.53)	1.7070 (2.42)	2.8767 (5.47)	2.0182 (4.78)
Constant	-1.8679 (-1.60)	-5.0709 (-4.13)	-3.5477 (-2.81)	-1.0416 (-0.80)	-4.0984 (-3.28)	-2.9692 (-2.58)
Choice-Specific Variables	Coefficient		(t -Statistic)	Coefficient		(t -Statistic)
$y_{ij}^{end(w)}$	0.0196		(2.10)	0.0105		(1.07)
$y_{ij}^{end(h)}$	-0.0161		(-1.19)	-0.0026		(-0.18)
No. Observations	246			1154		
Log Likelihood	-266.24			-529.11		

Appendix G STATA Programs for Mixed Mover-Stayer and Double-Hurdle Models

In the data set used to estimate these Mover-Stayer models, the individual identifier is 'newcase'. Each *newcase* has 4 observations, one for each state. 'Mover' is a dummy variable that takes the value one if the individual is identified as a mover by \hat{S}_j , and zero if not. 'Sjobsitk' is the job status of the individual at the key date, and takes the value 1 for a full-time worker, 2 for a woman working part-time, more than ten hours per week, 3 for a woman working part-time, less than ten hours per week, and 4 for a woman not working at that date; *sjobsit1* and *sjobsit2* are the equivalent variables for the state occupied at the first and second interviews.

G1. Maximum Likelihood Program

The following program, 'domovst1' maximizes the likelihoods specified in Sections G2 and G3, 'mixedms' and 'doubhurd', using the variables included in 'varlist', of which there must be at least one, with no constant. In both cases, the starting values are taken from the results of the estimation over the whole sample. The example shown is for transitions between the key date and the first interview, with conditioning on the state occupied at $t = -1$ achieved using an 'if' statement. Equivalent maximum likelihood programs were used for transitions between the first and second interviews, substituting *sjobsit1* for *sjobsitk* and *sjobsit2* for *sjobsit1*.

```
program define domovst1
version 5.0
local varlist "req ex min(2)"
local if "optional"
parse "*"
tempname b b0
clogit actual1 `varlist' `if', group(newcase)
```

```

matrix `b0'=get(_b)
eq eqn: sjobsit1 `varlist'
ml begin
ml function mixedms          */ or doubhurd /*
ml method deriv0
ml model `b'=eqn, nocons from(`b0')
ml sample mysamp `varlist' `if'
tempname lf V
ml max `lf `V', trace
ml post results
ml mlout results
end

```

G2. Program Specifying the Individual Contribution to the Mixed Mover-Stayer Likelihood

The following program specifies the likelihood function for each individual.

```

program define mixedms
version 5.0
local b ""1""
local f ""2""
tempvar nomin denomin div indlogl logl z1 state actual
gen double `nomin'=0
gen double `denomin'=0
gen double `state'=mod(_n-1,4)+1
gen double `actual'=( $\$S\_mldepn == state$ )
matrix score double `z1'=`b'
qui by newcase: replace `nomin'= $\$S\_mlwgt * cond(actual, exp(z1), 0)$ 
qui by newcase: replace `nomin'=sum( $\$S\_mlwgt * `nomin'$ )
qui by newcase: replace `denomin'=sum( $\$S\_mlwgt * exp(z1)$ )
#delimit ;
qui by newcase: gen double `div'=( $nomin[_n] / (denomin[_n])$ ) if  $\$S\_mlwgt$  ;

```

```

qui by newcase: replace `div'=0.895+(((`nomin'[_n])*0.105)/`denomin'[_n]) if
$S_mlwgt & mover==0 & sjobsitk==4;
qui by newcase: replace `div'=0.953+(((`nomin'[_n])*0.047)/`denomin'[_n]) if
$S_mlwgt & mover==0 & sjobsitk==1;
qui by newcase: replace `div'=0.946+(((`nomin'[_n])*0.054)/`denomin'[_n]) if
$S_mlwgt & mover==0 & sjobsitk==2;
qui by newcase: replace `div'=1 if $S_mlwgt & mover==0 & sjobsitk==3;
#delimit cr
qui by newcase: gen double `indlogl'=$S_mlwgt*cond(_n==_N, ln(`div'),0)
qui gen double `logl'=sum(`indlogl')
scalar `f'=`logl'[_N]
end

```

G3. Program Specifying the Individual Contribution to the Double Hurdle Mover-Stayer Likelihood

The program doubhurd is used with the same dataset as is described above.

```

program define doubhurd
version 5.0
local b ""1""
local f ""2""
tempvar nomin denomin div indlogl logl z1 state actual sumdiv
gen double `nomin'=0
gen double `denomin'=0
gen double `div'=0
gen double `state'=mod(_n-1,4)+1
gen double `actual'=( $S_mldepn==`state')
matrix score double `z1'=`b'
sort newcase
qui replace `nomin'=$S_mlwgt*exp(`z1')
qui by newcase: replace `denomin'=sum($S_mlwgt*exp(`z1'))
qui by newcase: replace `denomin'=`denomin'[_N]

```

```

#delimit ;
qui replace `div'=(((`nomin')*0.262)/`denomin') if $S_mlwgt & sjobsitk==4 &
`state'~=4 ;
sort newcase ;
qui egen double `sumdiv' = sum(`div'), by(newcase) ;
qui replace `div'=1-`sumdiv' if $S_mlwgt & sjobsitk==4 & `state'==4 ;
drop `sumdiv' ;
qui replace `div'=(((`nomin')*0.426)/`denomin') if $S_mlwgt & sjobsitk==1 &
`state'~=1 ;
sort newcase ;
qui egen double `sumdiv' = sum(`div'), by(newcase) ;
qui replace `div'=1-`sumdiv' if $S_mlwgt & sjobsitk==1 & `state'==1 ;
drop `sumdiv' ;
qui replace `div'=(((`nomin')*0.493)/`denomin') if $S_mlwgt & sjobsitk==2 &
`state'~=2 ;
sort newcase ;
qui egen double `sumdiv' = sum(`div'), by(newcase) ;
qui replace `div'=1-`sumdiv' if $S_mlwgt & sjobsitk==2 & `state'==2 ;
drop `sumdiv' ;
qui replace `div'=(((`nomin')*0.694)/`denomin') if $S_mlwgt & sjobsitk==3 &
`state'~=3 ;
sort newcase ;
qui egen double `sumdiv' = sum(`div'), by(newcase) ;
qui replace `div'=1-`sumdiv' if $S_mlwgt & sjobsitk==3 & `state'==3 ;
drop `sumdiv' ;
qui gen double `indlogl'=$S_mlwgt*cond($S_mldepn==`state', ln(`div'),0) ;
qui gen double `logl'=sum(`indlogl') ;
scalar `f'=`logl'[_N] ;
end ;

```


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